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INTERIOR OF THE GREAT POWER PLANT OF THE PARIS METROPOLITAN RAILWAY

THE POWER PLANT FOR THE METROPOLITAN STREET RAILWAY OF PARIS.*

By Emile Guarini.

The Metropolitan Street Railway of Paris, France, may easily be reckoned among the most important systems of the kind. Its increasing development even forces one to the conclusion that in a very short space of time it will become the most extended street railway system in the whole world.

The trains running upon it are made up of motor cars and trailers, propelled by means of a continuous or direct current of 600 volts, generated at the main station and also at sub-stations supplied with step-down transformers and converters.

The current itself is taken off by means of a contact shoe attached to the motor car; it slides upon a third rail, which is laid parallel to the track, and is insulated from the ground. Into this rail the direct current is turned by means of feed cables. After passing through the motors and doing its work the current returns along the track.

The object of the sub-stations is to transform or step-down the three-phase alternating current from the high tension of 5,000 volts, at which it issues from the main plant, to 600 volts and convert it into the direct current of same tension to be used in the motors. That portion of the system lying near the central station is supplied direct from it; while the more remote sections of the road are fed with the current, also generated at the central station, sent out at high tension and reduced or stepped down at the transforming station, situated upon La Place de l'Etoile near the Arc de Triomphe, and later at other points as they become necessary. It should not be overlooked that the central station contains also at least one transformer and a converter, or in lieu of them a dynamo which generates a direct current of 600 volts.

There are installed, moreover, at both the central power station and the sub-station, two batteries of Tudor accumulators which are composed of 260 cells each. The purpose of these batteries is, for a predetermined normal output or load, to limit the variations of voltage to 5 per cent. Besides, they fulfill the function of a flywheel or governor, by maintaining as constant as possible the load upon the generating dynamos up to a certain fixed point, regardless of the variations in the demands made by the system. The central station and also the sub-station at the Place de l'Etoile contain two sets of boosters of a capacity of 200 kilowatts each. The role which these boosters is intended to play, is that of maintaining constant the power produced by the generators, in that during the periods of light traffic they furnish the extra voltage necessary to the charging of the storage batteries, and when the traffic upon the road becomes heavy, they force the charge from the batteries out upon the line feeders in parallel with the current from the generators. The plant which furnishes the current for the Metropolitan Railway is situated between the Quai de la Rapée and the Rue de Bercy. This plant erected by Messrs. Schneider & Co. comprises an administration building and a machinery building, rather two adjoining buildings, one for the exclusive use of the generators and other accessories and the other for the boilers, coal bins, etc. This group of buildings covers only about two-thirds of the allotted space, thus holding in reserve a portion for future improvements. The generator building, 85 meters long, contains four sets of electric generators of 1,500 kilowatts capacity each, and two banks of transformers of 750 kilowatts, as also the auxiliary machines, such as pumps, exciters, and boosters, of the storage batteries. The batteries are installed in the sub-cellar of the administration building. The building for the boilers is somewhat longer than the machinery building and contains thirty boilers coupled in five sets of six boilers each. A third space, parallel to that of the boilers, contains the coal bunkers, having a capacity of 2,000 tons. The thirty boilers, also built in the works of Schneider & Co., at Creusot, are of the semi-tubular type, having two cylindrical steam retainers joined each by three short legs to the principal tubular body.

In the great boiler room of the plant at Bercy, the piping and the great dome or collector of steam are connected up by means of intermediate valves, so that all damage may be localized. The former is of copper, and the latter is of bended iron with copper elbows. The ashpans open into a gallery running the length of the boiler room and terminating at an elevator; in this gallery are run little cars for carrying off the ashes. This combination of the coal bunkers and ash gallery leaves the boiler room wholly unobstructed.

The coal for the furnaces is brought up to the rear of the building in boats; an electric crane takes it from the boats and dumps it into a hopper, which feeds it upon a system of conveyors and elevating buckets intended to transport it to the respective bins, after having automatically weighed it on its journey.

This system consists: 1. Of a subterranean conveyor passing under the Quai de la Rapée, having a length of 95 meters between the axles of the extreme sets of wheels and consisting of an endless metallic table formed of sections of sheet iron joined together and mounted upon a Burton chain which carries it along. These board-like sections are provided with castors or rollers, which roll upon the tracks attached to the apparatus.

2. Of an elevator consisting of a noria or chain of buckets, 24 meters high, from axle to axle of the extreme sets of wheels, fed by the above mentioned moving platform. This elevator empties into a hopper which conducts the coal upon an automatic scale, marked by the department for weights and measures, weighing it one ton at a time. The tripping gear for the opening and closing of the doors of admission and discharge of the coal into and from the basket of this scale are operated automatically.

3. Of a second carrier receiving the coal from the elevator through a hopper placed under the scale and intended to carry the coal above to the bunkers in which it is to be stored. This last carrier is composed of a series of little cars, of 60 liters capacity, attached to two endless Burton chains, and they run upon a track. The length of the carrier is the same as the first, viz., 95 meters.

The cars dump their contents on meeting a stop; by the moving of which from bin to bin the whole series of bunkers may be filled. These devices are calculated to dispose of 60 tons an hour, and the power required to accomplish the transportation of the coal to the extreme coal bunkers, passing over a course of more than 200 meters, with an elevation of 10 meters, is only 20 horse power. The work is performed by electric motors and requires the services of but two men. The steam engines to turn the alternators and one dynamo furnishing a direct current were also built by Schneider & Co. They are vertical compound condensing engines. However, if occasion require they may be instantly converted into high-pressure open-air exhausters.

The alternators and the dynamo are placed between the two crank arms. Each of these engines delivers 2,600 horse power at 70 revolutions per minute. The flywheel, having a diameter of 7.50 meters, weighs about 73,000 kilogrammes, and the weight of the main shaft with the two cranks will easily reach 20,000 kilogrammes.

In building the massive foundations for the support of these machines, it was necessary to make use of caissons and compressed air.

The engines are built upon the Corliss model, except that the wrist plate with its tripping levers is applied to the high-pressure cylinder alone. Knowing the conditions of regularity which must be fulfilled in order to permit of a successful coupling, in parallel, of the different groups of electric generators, and the shock which they will have to withstand, the governing mechanism has become the object of special care. Each engine is therefore provided with two governors; the one applied to the governing of its natural motion, properly speaking, viz., the operation of the tripping levers of the small cylinders; while the other, through the intermediation of servomotors, will operate admission valves placed close to each cylinder in case of a sudden relief from load caused by short-circuiting or what-not. The speed of the engine may be varied within certain limits by means of the first-mentioned governor.

The generating station of the Metropolitan Railway comprises, as has been said above, four groups of electric generators built by Schneider & Co., of Creusot, of which three furnish a three-phase alternating current and one a direct current.

The three-phase generators of the gang type are intended to furnish 1,500 kilowatts each as a normal production at 5,000 volts, with a frequency of 25, but they may easily be made to deliver 2,000 kilowatts. They are of fixed armature and rotating field type.

The chief characteristics of these alternators are the following: E. M. F. at the bus bars, 1,500 kilowatts at 70 revolutions per minute; composite volts at the bus bars, 5,000; amperes for $\cos. = 1{,}173$; amperes for $\cos = 0.75{,}230$; diameter of bore of the armature, 5,900 m.; exterior diameter of the field magnet, 5 m. 892.5; width of armature, 422 mm.; number of poles, 42; weight of the rotor, 26 tons; total weight of the alternator, 86 tons; excitation when loaded, 250a. at 100v.

The excess of temperature of the different parts of these alternators above the surrounding atmosphere, when working with a full load, is 28 deg. for the coils and 38 deg. for the iron.

The direct-current dynamo manufactured by Schneider & Co. has a slotted armature with bar winding having the similar poles connected in parallel, with shunt excitation. It delivers normally 1,500 kilowatts at 600 volts, but its capacity may be raised to 3,000 kilowatts at 3,350 amperes. In spite of this overload, the temperature of the parts rises but little above that of the surrounding air. Under a full load they scarcely exceed 11 deg. for the armature and 18 deg. for the field. The adjustment of the brushes remains constant without regard to the power delivered by the dynamo; and the tension does not vary 5 per cent, however great or small the load may be. Moreover, it returns under a full load 96.5 per cent of the power necessary for its operation. The field of this machine, a huge frame of cast steel of great permeability, is formed of four sections securely bolted together.

An axial spline adds great stability to the section of the frame, so that the deformation of the piece is practically 0. The field carries twenty poles cast in one piece with the frame. These poles are provided with an axial slot intended to reduce the effect of the transverse ampere windings; the induction coils are retained in position by pole pieces bolted to the poles.

The cast-iron pole pieces are of a special design, which considerably reduces the distortion of the field. It is well known that the effect of this distortion is to strengthen the magnetic field at that extremity of the pole piece which is in advance in the sense of the rotation, that is to say, that portion of it which is passing out of the magnetic field, and to weaken it at the other extremity, that is to say, at that portion which is just about to enter the magnetic field, precisely at the very point where there is great need of a sufficiently powerful field for the commutations; the brushes having to be in a generator shifted forward, that is to say, toward the rear beak of the pole. In diminishing the air gap at the entering edge of the pole, in order to increase it at the outgoing edge, in preserving the same mean air gap, the reluctance of the magnetic circuit is lessened at the entrance, which counterbalances the effect of the distortion, which endeavors to induce it to pass by way of the other edge or beak. In this wise, under a load, a sensibly uniform field is obtained in the air gap, and a perfect commutation. The armature of this dynamo, keyed upon the shaft of the steam engine, is composed of a cast-iron boss, upon which is keyed a cast-iron crown for the support of the disks which form the magnetic core of the armature.

These disks, made of steel with a very small coefficient of hysteresis, have a thickness of about 0.35 of a millimeter and are separated one from the other by sheets of paper. The boss, the crown of the armature, and the heads for holding the disks tightly in place have been specially disposed with a view to the creation of a very powerful ventilation.

The collector is of huge dimensions. It is composed of 1,080 sheets of red hammered copper, having a trapezoidal cross section and insulated with mica. It is joined to the winding by means of red copper sheets forming equipotential connections.

There are 240 carbon contact makers supported upon 20 bars which collect to current. The dynamo weighs fifty tons. The groups of exciters to the number of three are in reality rotary converters, consisting of two Schneider six-pole dynamos joined together by means of a clutch. They convert the current from 600 volts, taken from the system or from the storage batteries, into a current of 130 volts suitable for exciting the alternators.

Each group is capable of furnishing 70 kilowatts of current at a speed of 650 turns a minute, which provides excitement sufficient for two of the alternators. The motor and exciter are wound for shunt excitation. The efficiency of the group under a full load has been found to be 85 per cent, corresponding to an efficiency of 92.3 per cent for each one of the dynamos.

The heating of these machines scarcely attains 25 deg. above the temperature of the surrounding air.

Each group of boosters consists of a Schneider direct-current motor, run by a current of 550 volts or 600 volts, coupled by means of a clutch to a specially constructed Schneider dynamo, built for a delivery of 2,000 amperes, but may be run so as to discharge 3,000 amperes at a voltage of from 50 volts to 100 volts.

The two banks of static transformers at the Bercy plant, together with the converters, transform and convert the three-phase alternating current of 5,000 volts into a direct current of 600 volts. Each group having a capacity of 750 kilowatts comprises three monophase transformers reducing the tension from 5,000 volts to 430 volts, and a converter which turns this current of 430 volts into a direct current at a tension of 600 volts. The Ganz transformers are connected triangularly to the primary coils, the secondaries being independent. Each transformer having a capacity of 300 kilowatts, consists of two columns, brought together at their lower extremities by means of a plug fitted into the cast-iron base which serves to support the apparatus. These static transformers are adapted to be artificially ventilated. To this end they are installed on the top of a shaft or horizontal passage built of masonry which receives air from below, driven in and along the passage by means of a small electric blower. By virtue of this forced ventilation, the temperature of the transformers under full pressure rises scarcely higher than 20 deg. above the air surrounding them. They will, however, perform their work for several hours without this artificial ventilation, even at a maximum load. Their efficiency is about 98 per cent. The converters built upon the Ganz system transform the three-phase current at 430 volts into a direct current at 600 volts. The commutation of the three-phase current takes place in a unique magnetic circuit. These machines are started in much the same manner as the direct-current dynamos, and brought up to step with the alternators. They are constructed in very generous proportions, which renders them capable of working without inconvenience for a prolonged period at a pressure of 1,000 kilowatts. Under such condition the temperature of their various working parts does not exceed that of the surrounding atmosphere by more than 25 degrees for the armature and 11 deg. for the field. The maximum efficiency of these machines reaches 95 per cent under a full load.

Each battery of accumulators has a total capacity of 1,560 ampere hours. It is capable of sustaining shocks of 3,000 amperes. They are attached in deviation (shunt) to the direct-current bus bars.

The weight of water evaporated per kilowatt hour has been estimated at 9K.067 for the direct-current group; while for the alternators, the consumption of steam per kilowatt hour, measured upon the amount of direct current delivered by the converters, is represented by the figures 11K.062, which may be considered very satisfactory.

* Specially prepared for the Scientific American Supplement.

METALLIC CALCIUM FROM LIME.

A problem that up to the present has stubbornly resisted all attempts at its solution, to wit, the electrotype production of metallic calcium from lime, has at last yielded to the onward march of science. The triumph was accomplished in the Electro-Metallurgic Institute at Aix-la-Chapelle, by Prof. Borchers and one of his engineering students, Herr Stockem. The process employed is similar to that of the production of aluminium from clay, as described in the Zeitschrift für Elektrochemie. Aluminium, as is generally known, is separated out of a molten mixture of cryolite and clay, and the process is even simpler, since only one material is submitted to electrolysis, calcium chloride, to wit, which melts at about 800 deg. C. (1,475 deg. F.).

Certain peculiarities of calcium, not possessed by aluminium, make special care in arranging the electrodes necessary, and even then many failures are encountered. Without entering into a history of the process employed by the professor and his pupil, we would say that the possession of a method of producing metallic calcium at will, easily and cheaply, is of great importance to chemistry, in its application to the arts and manufactures. It is not, of course, available for manufacturing vessels, implements or tools, or in fact, any metallic object, since it becomes soft like summer butter in the winter time, and besides it does not keep when exposed to the atmosphere, but is converted by it into calcium oxide, quick-lime, to which it burns without becoming hot or even warm (the heat becoming latent, or stored away, to be subsequently developed, as when quick-lime and water are brought together). It is, as remarked, in the chemical industries that calcium will find its greatest usefulness, and especially in organic chemistry, where the need for a cheap metal, with powerful reducing properties, stronger than those of aluminium, magnesium, and zinc, and

weaker than metallic sodium and potassium, has for a long time been felt.

The cost of metallic calcium—about $22.50 per pound —has hitherto precluded its use in this capacity (i. e., as a reducer), but, by the new process, this cost is lowered by about five thousand times, it being produced at the amazingly low rate of 45 cents per hundred weight—a fact whose importance to organic chemistry it is impossible to overestimate. Besides its importance in this direction, the discovery is of high interest to the iron industry. To free iron from phosphorus, sulphur, and oxygen, an addition of aluminium to the molten ore has hitherto been necessary, and while a specimen of iron containing aluminium is better than one containing phosphorus, or sulphur or oxygen, it is not as good as absolutely pure iron as regards resistance to strain and fracture. Should the theory now maintained by experts that the amount of calcium necessary to reduce these deleterious contents be so small as to virtually leave the iron in a state of purity—should this be confirmed in actual practice, and should it be found that the calcium plays no deleterious part, the new industry of calcium producing has a most brilliant future. The same may be said for metallic strontium, which is now being produced cheaply and plentifully.—Nat. Drug.

CONTEMPORARY ELECTRICAL SCIENCE.*

DARK CATHODE SPACE.—H. Ebert and P. Ewers have made a series of careful measurements of the thickness of the dark cathode space, and have rigidly proved the law which expresses that thickness d as a function of the pressume p. The law has the form $d \times p^m = d_o =$ constant, where m is a constant depending upon the nature of the gas. The electrodes employed included aluminium plates of radii 1 cm., 1.4 cm., and 0.7 cm., and a sphere 0.5 cm. in radius. In oxygen, m has the value 0.835, and d_o the value 1.556. In nitrogen, the corresponding values are 0.796 and 2.11. In hydrogen, they are much higher, being 0.941 and 6.87 respectively. In carbonic oxide they are lower, being 0.636 and 2.51. The authors distinguish two groups of gases. One of them comprises hydrogen, carbonic acid and nitrogen, while the other includes carbonic oxide and oxygen, hydrogen possessing the greatest and oxygen the smallest dark spaces at the same pressure. An interesting conclusion arrived at is that the size of the dark space is in direct proportion to the energy consumed by the tube. It appears, therefore, that a good deal of the energy supplied is used up in forming the dark space.—Ebert and Ewers, Ann. der Physik, No. 1, 1903.

VISIBLE MOLECULES.—A paper which is bound not only to create a sensation, but to profoundly influence molecular physics is that by H. Siedentopf and R. Zsigmondy on "The Visibility of Ultra-Microscopic Particles." It describes a method of making small particles visible which considerably extends the range of microscopic vision, and brings us within a short distance of molecular dimensions. The method is a form of "dark field illumination" with sunlight filtered through a narrow slit. The particles specially examined are gold particles in ruby glass. These particles are exceedingly small, and although they cannot be seen as they actually are, they appear as diffraction disks about 1 mm. in apparent diameter. Since their real size is 20 $\mu\mu$ on the average, this means an enlargement of 50,000 diameters. The objection that the disk does not show the real object also applies to the fixed stars, which appear in the most powerful telescope only as diffraction disks. The limit of the method is at about 5 $\mu\mu$, or about 10 times the diameter of a molecule, and the authors prove that some of the gold particles are smaller than that limit. By counting the number of particles in a certain volume and estimating the total amount of gold present, they arrive at the size and weight of the particles. Molecules themselves could only be seen if they could be made intensely self-luminous, or if the eye could be made much more sensitive.—Siedentopf and Zsigmondy, Ann. der Physik, No. 1, 1903.

CAPILLARY ELECTROMETER. — The electrometer in which only a drop of mercury is used (see the Electrician, vol. xlix., p. 418), is very advantageous for null methods, but maxima cannot be observed by its means, and the drop is liable to slip out of the tube. P. Boley describes two new types which lend themselves to all kind of measurements. Since the sensitiveness depends upon the mobility of the meniscus and the power of the microscope, each of these two factors should be made a maximum. The mobility of the meniscus would be infinitely great for a form of the electrometer in which the mercury would be in a state of indifferent equilibrium. Such a state could be realized by putting the capillary tube into the shape of a hyperboloid of revolution. But most capillary tubes approximate to this shape more or less, and have a region of indifferent equilibrium slightly below their thinnest bore. By choosing a tube of nearly hyperboloidal shape, the author is enabled to measure an E. M. F. of 10^{-5} volts with an enlargement of 840 and a water manometer. The bore is 0.25 mm. and the mercury thread is only 2.75 cm. long. Another form of tube resembles Lippmann's reversed pattern, and has a bore as large as 1 mm. It measures 10^{-4} volts.—P. Boley, Journ. de Phys., December, 1902.

POLONIUM.—Mme. Curie, the discoverer of polonium, maintains that it is not yet decided whether polonium is an element or not. The supposition that any radioactive substance which has different properties from other radio-active substances is a separate element was verified in the case of radium, but is rendered uncertain by the phenomena of induced radio-activity. The case of polonium is rendered doubtful by the fact that the spectrum only shows the rays of bismuth. On the other hand, it is possible to concentrate the radioactive substance contained in "radio-active bismuth," and this would not be possible if bismuth alone were present. Also, on sublimating bismuth sulphide, the sublimated portion is the more radio-active. It is possible that polonium does not possess any sensitive spectroscopic reaction. A serious point is the gradual loss of activity, which in one case amounted to 50 per cent in eleven months. But Marckwald has succeeded in obtaining a polonium preparation which does not show any sensible loss. It would be interesting to determine the atomic weight of the element, and this the authoress is working at whenever she has a sufficient quantity of radio-active bismuth available.—Mme. Curie, Physikal. Zeitschr., January 15, 1903.

VELOCITY OF RÖNTGEN RAYS.—The prevailing theory that X-rays are but an irregular series of single wave impulses, making up what might be called an optical "noise," has received another confirmation at the hands of R. Blondlot. He tested whether the different varieties of X-rays, which we know to have very different powers of penetration, differed in their velocities of propagation, as do the rays given out by the different radio-active bodies. He found that whatever the kind of vacuum tube from which X-rays might be obtained, their velocities were always equal to the velocity of light in air. The experiments were made by the method already described (see the Electrician of November 21, p. 189). Indeed, the previous experiments made it probable that the rays had a fixed velocity, as otherwise the maximum could not well have been a decided one, however the tube might be working. The author also found the natural conclusion verified that the velocity is independent of the medium through which the rays are propagated, since there is no refraction. He verified this for wood, paraffin, vaseline oil and essence of terebenthine.—R. Blondlot, Comptes Rendus, December 29, 1902.

PHOSPHORUS EMANATION.—Air becomes conducting when placed in the neighborhood of a stick of phosphorus. Barus has shown that it also acquires the power of condensing water vapor, even though it be not saturated. Whether we have here a phenomenon of true ionization has been answered in the negative by Schmidt, and in the affirmative by Harms. E. Bloch has therefore studied the effect under improved conditions. He passed a current of perfectly dry air over the phosphorus, and found that it showed no fumes. It had an electric conductivity which reached a saturation value at a certain point. Since at the same time no current is produced on inclosing two electrodes into a charged cylinder containing the emanation and putting one electrode to earth, we have evidence of a true ionization. The mobility of the ions is extremely feeble, being of the order of 1-300 mm. per second with a field of 1 volt per centimeter. This mobility is very much less that that of ordinary gaseous ions, but is the same as that found by Townsend in gases newly produced by electrolysis. These also agree with phosphorus emanation in their condensing power.—E. Bloch, Comptes Rendus, December 29, 1902.

HALL EFFECT IN FLAMES.—In a recent communication (see the Electrician of December 19, 1902, p. 341) G. Moreau studied the mechanism of conduction in a flame charged with an alkaline salt vapor, and came to the conclusion that a flame contained no free ions, and that metallic electrodes were essential to its ionization. The mobility of the negative ions varies from 660 cm. per second in a cool flame to 1,320 in a hot Bunsen flame. The mobility of the positive ions is 80 cm. per second in the standard field, whatever may be the temperature. These mobilities may be utilized for calculating the Hall effect in flames. The author makes a few such calculations for various KCl and NaCl flames, and gets values fairly agreeing with experiment, but occasionally somewhat too high. The negative ion seems only to depend upon the nature of the metal and the concentration of the metallic matter. It appears to consist of a negative electron carrying with it some neutral molecules. The positive ion consists of the atom with an accretion of neutral molecules. The preponderating influence observed by Arrhenius in the conductivity of saline vapors is thus accounted for.—G. Moreau, Comptes Rendus, December 29, 1902.

DIFFRACTION OF RÖNTGEN RAYS.—H. Haga and C. H. Wind maintain against the criticism of B. Walter, not only that they have photographed a true diffraction effect of Röntgen rays, but that they have obtained even more unmistakable evidence of it than they had before. They mounted two slits 75 cm. apart on a bench in the shape of an iron girder. One of the successful photographs of diffraction fringes was obtained after 9½ hours' exposure with a specially soft tube, which the authors succeeded in keeping soft for that length of time, although the water used for cooling was boiling all the time. The other two photographs required two tubes each, and took 31 and 40 hours respectively. All these showed very slight veiling; but they all showed a perceptible broadening of the image of the slit. That this broadening is due to diffraction, and not to irradiation or concussion, is proved by the fact that it is found only in the case of narrow slits, and not at points where the slit is broadened. The values for the wave-length of X-rays deduced from the three photographs differ widely, but are in any case extremely small, and more of the order of the size of a molecule than of the order of length of light waves. The three values given are 0.16, 0.05, and 0.12 $\mu\mu$ respectively. The authors attribute the difference to a difference in the degree of hardness of the various tubes.—Haga and Wind, Ann. der Physik., No. 2, 1903.

ABNORMAL CATHODE FALL.—According to the ionic-shock theory, the amount of ionization near the cathode depends essentially upon the number of neutral molecules in the unit of volume. This number, called the "specific number of molecules" n, is of importance in a number of formulæ governing vacuum phenomena, and its discoverer, J. Stark, proposes to use it for formulating the abnormal cathode fall of the glow current. If that is done, it appears that theoretically the relation between cathode drop and current should not be linear. Since a linear relation has been, however, found by some observers, the author has made new measurements with platinum electrodes in a vacuum free from fat. The uniform result is that there is no linear relation between cathode fall and current strength. The fact is that the self heating of the cathode often stimulates a linear relation. The electric work in the dark cathode space is equal to the product of the cathode fall into the total current. The work spent on the positive ions is converted into heat at the cathode. With a constant pressure, and an increasing temperature, the normal cathode fall remains constant, but the abnormal cathode fall increases while the normal current density at the cathode diminishes.—J. Stark, Berichte der Deutschen Phys. Ges., No. 1, 1903.

MAGNETIC EFFECT OF ELECTRIC CONVECTION.—V. Crémieu writes on the present state of the question of electric convection, and does his best to defend himself against the positive results obtained by Pender. The experimental problem, he says, which was already surrounded by numberless difficulties, is further complicated by a new disturbing cause which he has unearthed. He has found that, besides the theoretical effect of the convection of charges, an astatic magnetic system contained in a closed electric screen may, under certain conditions, be subject to a magnetic action which strongly deflects the needle, and can even demagnetize it. This action may be produced by placing the astatic system in its screen above a horizontal metallic plate attached to a conductor of feeble resistance and no inductance, whose other terminal is put to earth. If, now, a condenser is discharged anywhere along the conductor, the needle receives a violent shock which displaces its zero. This effect can be stopped by introducing a high liquid resistance or a larger metallic screen. The author points out that a disturbing magnetic effect may be produced by a loss of charge of the body conveying the electricity. He thinks that the final decision of the question will involve much time and trouble yet.—V. Crémieu, Journ. de Phys., December, 1902.

ELECTRIC DISSIPATION IN FOG.—A. Gockel has studied the effect of fog upon the distribution of atmospheric potential and upon the mobility of positive and negative ions. He comes to the conclusion that ascending air-currents, such as are prevalent in cyclonic areas, carry with them negative ions. These give rise to the formation of clouds, as a rule, since the negative ions are the most effective condensation nuclei. At Freiburg the author has observed a quicker dissipation of positive electricity with a falling barometer. A surplus of positive ions, as always exists near the mountain tops in fine weather, may be reversed by fog, since the positive ions are screened off and prevented from coming through from above. During snowstorms there is a quicker dissipation of positive electricity, and, therefore, a prevalence of negative ions. The low-lying fogs occurring in autumn and winter are almost always produced by descending air-currents, such as prevail during anti-cyclones. These descending air-currents take down with them a quantity of positive ions. This gives rise to the strong surplus of positive ions in the layer above the fog, as found by Ebert in his balloon voyages. The author suspects a close relation between dissipation and atmospheric pressure.—A. Gockel, Physikal. Zeitschr., February 1, 1903.

AN OPTICAL PYROMETER.—L. Holborn and F. Kurlbaum describe an optical pyrometer constructed upon a new plan, in which both sources are viewed direct, and the standard is adjusted to a sufficient intensity to merge into the source measured. The instrument consists of a telescope which produces an image of the source under investigation in the plane of vision, and in the same plane is mounted a loop of incandescent filament contained in a circular globe, which does not perceptibly influence the optical system. A red glass tinted with cupric oxide is inserted in the eyepiece, so that a homogeneous radiation is secured. Under ordinary circumstances a simple red surface is seen through the eye-piece, and on it the black filament. The current is then turned on, and is increased until the filament can be no longer distinguished. The filament appears to dissolve in a fiery gas, and it is impossible to locate it except by the terminals, which remain cooler and, therefore, less brilliant. The photometer or pyrometer is calibrated by means of a radiating black body, as described by Lummer and Pringsheim.—Holborn and Kurlbaum, Ann. der Physik, No. 2, 1903.

EDISON PHENOMENON.—According to M. Allegretti, the Edison phenomenon, consisting of the passage of electricity from the extreme negative end of the filament of an incandescent lamp to a metallic plate introduced into the bulb, has not yet been fully explained, although much work has been done upon it by Preece, Fleming, and others. The main question is as to whether we have here a phenomenon of ionization or a true projection of negative particles. The author prepared a special vacuum tube having three openings by means of which the two electrodes and the metallic plate could be easily replaced. He found that the current between electrode and metallic plate decreases rapidly as the distance increases, and less rapidly as the area of the plate diminishes. The phenomenon produces no effect upon a sensitive plate wrapped up in black paper. A magnetic field weakens the current perceptibly, especially at the lower pressures. The author believes that the phenomenon is primarily due to ionization, but that at the higher vacua it is enhanced by the production of cathode rays which may be deflected in the same way as the ordinary cathode rays by a magnet.—M. Allegretti, Physikal. Zeitschr., February 1, 1903.

POLAR HEATING PRODUCED BY SPARKS.—According to E. Villari sparks from a condenser passing from one pointed thermo-couple to another or to a sphere or disk heat the thermo-couple in nearly the same proportion, no matter whether it is positive or negative, but the heating greatly depends upon the gas through which the sparks pass, being about 2½ times as great in nitrogen as it is in hydrogen. When the sparks are supplied by an induction coil, the heating is much greater at a negative thermo-couple than at a positive one. This difference of heating is a peculiar phenomenon which is not due to any difference in current intensity produced by reversal. In rarefied nitrogen, which has a small resistance, both direct and re-

* Compiled by E. E. Fournier d'Albe in the Electrician.

versed sparks pass and the discharges are much more energetic. Therefore, the polar heating by these discharges is much greater than in nitrogen at atmospheric pressure. By passing the same current through two bulbs in succession, one of which contains nitrogen at ordinary pressure and the other rarefied nitrogen, it is found that the cathode is always more strongly heated than the anode. The author recalls the analogy of the electric arc, which experiences a higher resistance in hydrogen than in air.—E. Villari, Physikal. Zeitschr., February 1, 1903.

NEW FOLDING OPERA GLASSES.

UNDER the name of "La Mignonne," M. Petit, of Paris, has just put upon the market a double opera glass of very ingenious and careful construction, which instantaneously opens and closes like an ordinary portemonnaie and which occupies hardly any more space than the latter in the pocket. The apparatus consists of a flat and light frame, carrying at its upper part the oculars, which are fixed upon guides of sufficient length to direct the rays and serve as diaphragms placed at the proper spot. These oculars may be made to slide by means of a focusing screw with a milled head. At the lower part are placed the objectives, which are mounted upon a pivot fixed on the line passing through their center, thus permitting of their being turned around their axis in order to bring them to a position at right angles with the plane of the frame, or else to place them in the plane of the latter, according as the apparatus is open or closed. The whole is inclosed in a flat leather-covered metal case provided at the sides with small bellows to permit of its extension, and to form a true camera in which the opera glass is housed. This case is of elegant form and devoid of angles, and has been made as small as possible without the sacrifice of any part of practical use. A small button in the form of a rounded T projects slightly externally, and, after the case has been opened through a pressure upon its clasp, permits of turning the objectives to an operative or inoperative position.

The focusing of the apparatus is performed in the same way as in opera glasses of the usual type, and this is one of its important characteristics, since it is one of the first folding glasses, in which the screw for the regulation of the focus has been preserved. This permits of its being easily used with one hand.

NEW FOLDING OPERA GLASSES.

1. Method of using. 2. General view.

The real magnifying power of the instrument is $3\frac{1}{2}$ diameters, which is amply sufficient for the theater. The manufacturer, however, has provided for this same model special glasses of greater power that give a magnification of $4\frac{1}{2}$ diameters. Under such circumstances the apparatus is capable of rendering genuine services to tourists, frequenters of the race track, and even to army officers.

Optically, the instrument presents every quality requisite—achromatism, perfect centering, diaphragms, and camera obscura forming a sunshade. The cleaning of the objectives is simple and does not necessitate any dismounting. The construction is strong and no aluminium enters into it. The thickness of the largest size is 6-10 of an inch when closed, and the weight is approximately 5 ounces. Another and smaller size for ladies is of the size of a portemonnaie, and weighs but $3\frac{3}{4}$ ounces.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

AN UNRECORDED PROPERTY OF CLAY.*

SOME years ago the writer found that ordinary clay, such as is used for bricks, and commonly spoken of as plastic clay, would, if dried sufficiently to remove nearly all its moisture, lose its cohesive properties, and would, if water were afterward applied to it in considerable quantities, become an almost liquid mud. On the other hand, clay which has not been so dried will not absorb any more water, and will lose only some of its outside particles in the washing. The writer has been unable to find any reference to this property of the material in question in the text books at his disposal.

It came to his notice under the following circumstances:

The main line of the Canadian Pacific runs for nearly 150 miles through a portion of British Columbia, situated between the eastern slope of the Cascade Range and the western slope of the Gold Range. There is no regular rainfall over this area, and crops cannot be grown without irrigation. A good many thunderstorms do occur in the summer, but only over very limited areas, and the rainfall from them runs away quickly without soaking into the ground to more than a depth of one or two inches, and is dried off in a few hours by the rapid evaporation incident to the region. . . . Water has been lavished upon the fields for nearly forty years, and has been the cause of numerous landslides, one of the greatest of which occurred in 1881, when about 100 acres slid forward for nearly a quarter of a mile, falling in that distance about 300 feet, and completely blocking the Thompson River for about three days by forming a dam 75 feet or more in height. Many similar slides on a smaller scale have occurred since that date, but generally, with slower movement and less disastrous effect. One of these is of large area and includes a portion of the railroad line; it has required constant watching and has been a cause of much anxiety to the railroad officials, because, although its forward progress has been slow, it has begun to move, year after year, at a date about three months after the beginning of the irrigation season, and has continued moving for about the same period.

In 1886 the Canadian Pacific Company took legal proceedings against the parties irrigating the fields above this slide, and it devolved upon the writer to furnish the legal advisers for the company with evidence to prove that the slide was due to the action of irrigation water. An investigation was made by the writer in consultation with Messrs. Stanton and Schuyler, who were employed by the company, as experts in hydraulic engineering, and, particularly, in irrigation practice, and with Mr. H. J. Warsap, manager of the Canadian Pacific Railway Portland Cement Works at Vancouver, an expert in clays. At the slides were found beds of clay so exceedingly dry and hard as to have the appearance of soft sand stone, and still retaining the marks of picks in the slopes of cuttings, where dressed many years ago. When a block of this dry indurated clay was placed in a soup plate and water dropped upon it, the clay absorbed 50 per cent of its own weight without change of form or other visible effect, but when it had absorbed about 60 per cent of water, its structure completely collapsed and became as fluid as water.

This was considered by us as conclusive evidence that the irrigation water which had been poured for weeks and months on these beds of clay had been the cause of the slide, but, in court, this argument was met by a demand from the opposing counsel to be told why the bluffs of this material, which were washed at their base by the river, did not disintegrate and slide. Several ingenious theories were offered to account for this, but were not convincing, and the writer now thinks that it was because these bluffs had never been dried out below high water mark, and the material in them, therefore, did not possess the property of soaking up water and of finally collapsing. . . .

A year or more after the trial, the writer, while experimenting with Mr. Warsap on some clay, which had been dried for other purposes, found that it gave the very same results as the dry clay from the interior of the Province. This led to experiments with other clay, and it was found that they all lost their cohesive properties when the moisture was removed.

It is probable that this property of clay has been the cause of many of the landslides which have occurred this year in the valley of the Oldman and Belly rivers, between Medicine Hat and the Crow's Nest Pass, for there has been an exceedingly heavy rainfall over these valleys during the year for the first time since they have become known.

* Extracts from a paper by H. J. Cambie, M. Canadian Soc. C. E. Read before that Society December 4, 1902.

HOW PEAS ARE CANNED.

THE season of canning activity at the two plants in Rome, N. Y., and in others in surrounding villages, is now on in good earnest, and from this time till the cold weather of the approaching fall there will be no cessation. The season for opening is about a fortnight earlier than that of last year.

Peas are the first crop to mature, and the early varieties, commonly known as June peas, are of a quality seldom equaled, and the indications are for a good yield. Central New York might well be called the home of the canning industry of the Empire State from the number of factories here. One of the largest, and perhaps the largest, is on the banks of the Black River Canal, about half a mile north of its junction with the Erie Canal. In connection with the factory there is a large farm, where are grown some of the products put up in cans, while the farmers round about furnish the rest on contracts for acreage. In the course of the busy season many men, women, and young people find employment, and many a family's little store of money is materially increased.

The industry of putting up canned goods is rapidly growing, and the processes by which the different crops are made ready for the market form an interesting sight. It is hardly possible to conceive the rapidity with which the work is carried on and the important part played by machinery. Take, for instance, the canning of peas, where the vines are cut in the field by a mowing machine and loaded on the wagons the same as is done with hay. Arriving at the sheds of the factory as wanted, they are placed on an endless chain and carried overhead to the workmen who tend the machine known as the "viner." In looks it resembles a large, old-fashioned revolving squirrel cage, in which are paddles which beat the pods and allow the peas to fall out through the meshes of the cage, while the vines and pods are carried by the endless chain to the silo, some distance away. As some pieces of vines and pods pass through with the peas, they are run through a squirrel cage which, revolving, causes the peas to be separated from the other substances, when they pass out of it into trays.

Passing onward, the peas are next poured into a machine reminding one of the old-time fanning mills seen in farmers' barns. Here they are further cleaned before passing through into the "grader," which is another cylinder, in which there are several sections with different sized meshes, and the peas roll along until they come to the mesh which permits them to fall through. All the while they are in this cage dropping water is washing them and carrying out the dirt that may be on them. Each size is now labeled and kept separate.

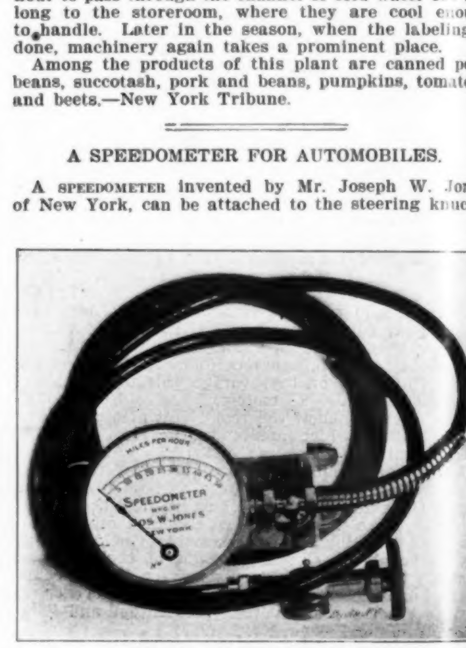
The "blancher," as it is called, is a trough of boiling water, through which the trays of peas are carried on the endless chain, requiring about ten minutes to pass twenty-five feet. As some of the skins of the peas, and possibly other dirt, may yet be clinging to the peas, they move on to the second series of squirrel cages, where the revolving motion again cleans them while cold water is continually dripping into the cage and on them. Now they pass out on to a belt about three feet wide and slowly move along between rows of women, whose business it is to pick out any bad peas or any other foreign substance. Dropping from this table into trays, they are carried by men to the filler. This is the machine that automatically fills the cans, which are dropped down through tubes from the storeroom above. When the can falls into position on the moving chain it is carried under the spout, which is then automatically opened, allowing the same quantity of peas to fill each can, at the rate of seventy to eighty cans a minute. The movement is so well timed that its place is taken by an empty can while it moves under the pipe through which the hot liquid is automatically measured and poured into it. The can now swings on its course, going through a brusher, or wiper, where it is cleaned and any surplus on top brushed off. Two boys now place caps on the cans as they move along past them to the soldering machine, with which is combined the "acider," which prepares it for taking the solder. After they come out of there they are branded with the quality and grade while on the way to the "dotter," who solders the little hole in the center of each cap. The inspector then takes his turn, and if the cans are all right they are soon at the end of their first journey, as they pass on to a table, when they are removed and put into large steel crates, preparatory to a second journey of some 150 to 200 feet under ground on an endless chain to reach the building where the "cookers" are.

Coming out of the "cookers," the crates now go on to a slowly moving chain, which takes about half an hour to pass through the channel of cold water 150 feet long to the storeroom, where they are cool enough to handle. Later in the season, when the labeling is done, machinery again takes a prominent place.

Among the products of this plant are canned peas, beans, succotash, pork and beans, pumpkins, tomatoes, and beets.—New York Tribune.

A SPEEDOMETER FOR AUTOMOBILES.

A SPEEDOMETER invented by Mr. Joseph W. Jones, of New York, can be attached to the steering knuckle



DASHBOARD SPEEDOMETER, SHOWING FLEXIBLE SHAFT, FRICTION PULLEY, AND RING FOR SAME.

or the dashboard. In the latter case the mechanism of the instrument is driven through a flexible shaft, instead of directly, by a small friction wheel rubbing against a rim attached to the spokes. The general appearance and details of the speedometer can be seen in the illustration and diagram. The metal ring, C, is pivoted on the shaft, A, and is linked by a wire, E, to the grooved disk, D. This disk is slidable along A.

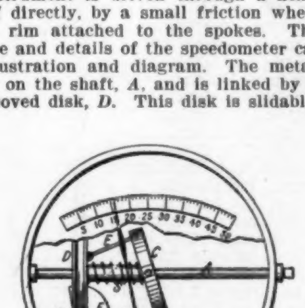


DIAGRAM OF SPEEDOMETER.

and when centrifugal force tends to move C to a position at right angles to A, the ring pulls D along with it on the shaft. This lateral movement of D serves to rotate cam F slightly around its pivot, G, by means of pin, H, engaging slot in disk, D. The movement of cam, F, is communicated through pin, K, to arm I, which moves indicating needle, L. The instrument is both simple and accurate, and gives constantly to the driver an indication of the speed at which his machine is traveling.

THE NEW AUTOMATIC HATTERSLEY LOOM.*

By the English Correspondent of the SCIENTIFIC AMERICAN.

SOME interesting experiments are being carried out in England with two types of automatic looms, the Northrop and Hattersley machines, respectively. For some time past, textile machinists have been endeavoring to obtain a power loom which shall be perfectly automatic or self-feeding in regard to the weft yarn. The refilling and rethreading of the shuttle entails considerable leakage in the action of the loom. Hitherto this work has been performed by hand, but for a long time efforts have been made to devise a system by which the action might be accomplished by mechanical means. The great difficulty to overcome in the solution of the difficulty was to discover when the length of yarn on the bobbin was reduced to such an amount as to approximate in length a few traverses of the piece. From this it will be realized that the device to fulfill this purpose would have to be almost human in its action.

Simultaneously two looms have been devised which accomplish this object. One is the Northrop loom, which has been described in the SUPPLEMENT and which is so much in use in the weaving mills of this country, and the Hattersley, the recent invention of Messrs. George Hattersley & Sons, of Keighley, Yorks. The present competition in England to discover which of these two devices is the most efficient in this requisition has been brought about by the manufacture of five hundred of the Northrop looms for operation in the Lancashire mills.

In the Northrop system, where cops are utilized, the operator places the cops on a specially shaped skewer. These skewers are inserted in a magazine, the loose thread is found, and placed in position, and when the weft breaks, one of these skewers is forced down into the shuttle, pushing out in its progress the empty skewer, which drops into a box placed underneath the stay of the loom. When picking the shuttle automatically threads itself, and weaving proceeds in the ordinary manner. It must be pointed out, however, that the cop is changed without stopping or even reducing the speed at which the loom is running at the time.

But in the Hattersley machine the shuttle is automatically changed. The shuttles are contained in a magazine, and when the yarn breaks, the loom automatically stops for a moment while the empty shuttle is mechanically replaced by a charged shuttle and then resumes working on its own initiative. All that the operator has to do is to see that the shuttles in the magazine are kept supplied with weft and that the magazine is always well provided with charged shuttles. From this it will be seen that the salient difference between the two systems is that in the Northrop looms the change is effected while the machine is running at full speed, whereas in the Hattersley principle the loom is stopped, but as the cessation is only momentary, it is not worthy of consideration.

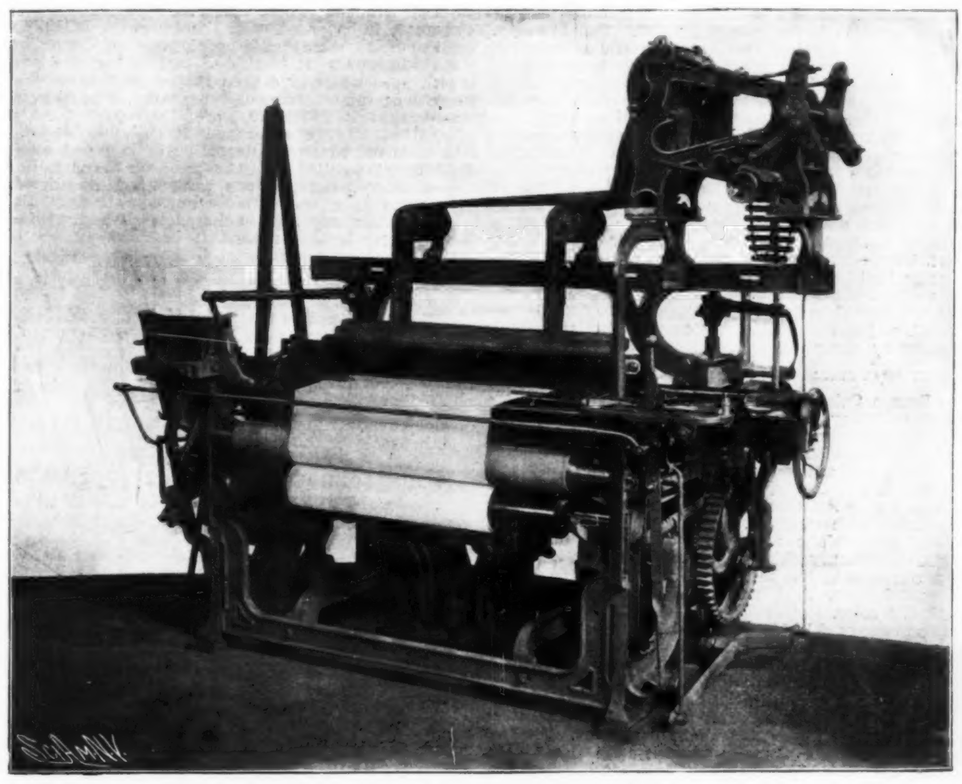
The Hattersley loom is adapted to a wide range of work, such as ordinary, twilled, striped, cotton fabrics, worsted costumes, cotton warp, Italian cloths, luster weft dress fabrics, double-weave worsted coatings, etc.

The magazine containing the shuttles charged with the weft is fixed on the breast beam of the loom opposite the box on the lathe. When the weft gives out or breaks, a weft fork comes into action and stops the loom, and the shuttle comes opposite to the magazine when the loom ceases running. By means of an ordinary loose pulley, a pap wheel on the low shaft, provided with four tappets, is actuated by the driving belt of the loom. These tappets communicate with the mechanism, which lifts the front of the shuttle box, ejects the exhausted shuttle, recharges the box with a filled shuttle, and restarts the loom, respectively. As all these actions are performed automatically, the person supervising the running of the machine has nothing to do beyond keeping the magazine well supplied with full shuttles and placing the end of the weft from the cop in each shuttle in a clip, so that immediately the loom stops for a new shuttle the end of the weft is held while the shuttle picks up for the first time. From this it will therefore be realized that the machine mechanically performs the work of introducing a new shuttle, which has hitherto been achieved by hand, with momentary celerity. It must also be pointed out that by means of this arrangement any possibility of the cloth being thicker or thinner in places than is required is entirely obviated. The only serious fault that can possibly occur is of two picks of weft in the same shed part way across the piece, and occupying the same space as would otherwise be obtained with one pick.

With the ordinary lines of cheap commercial goods such a fault is by no means serious, but if a superfine piece of weaving is being carried out, the occurrence of such a fault is overcome. In this instance when the shuttle working in the loom is nearly run out, a button is pressed, with the result that the expended shuttle is ejected automatically, and a full one simultaneously brought into use. This action of course necessitates more attention to the loom from the operator, since should the shuttle run out without the weaver being aware of the fact, the loom will come to a dead stop, when the supply of weft is exhausted, and the loom has then to be restarted in the ordinary manner. As operators, being human are not infallible, however, and the consequent possibility of the operator failing to notice the nearly exhausted shuttle and omitting to press the controlling button in time, a new device has been introduced. This is a weft indicator or feeling motion, which comes in contact with the weft in the working shuttle at every alternate pick. Previous to the last layer of yarn running off the bobbin, this feeler actuates the changing mechanism and the charged shuttle is brought into use before a broken pick can enter the shed. This is accomplished by an ingenious utilization of the existing weft-fork arrangement, a second fork being introduced and placed beside the first one, the head of the fork hammer being broadened out so as to admit of its operating both forks as occasion requires. In the event of the weft breaking in the shuttle the original fork stops the loom and the weaver attends to, and repairs, the break in the usual manner. In order to permit the feeler to perform its work with facility, a slot is cut into the front plate of the shuttle-box, and a corresponding slot in the grooved side of the shuttle, and in the working the shuttle slot comes opposite that in the box-plate. While in this position, and when the slay is up to the felt of the cloth, the feeler passes through the slots to ascertain whether weft be present or not. If it is there in sufficient quantity it raises its fork and permits the work to go on. When the weft is nearly exhausted it leaves the fork to operate and this changes the shuttle. By this ingenious arrangement no broken picks can be present in the material. Another distinctive feature of the Hattersley loom is that it is changed without the reshuttling mechanism being affected in any way. Furthermore there is no diminution in the running speed of the automatic loom as compared with the ordinary machines—a most important consideration. With the Northrop loom this fast running is not possible, since it performs some 30 picks a minute less than the ordinary loom. The Hattersley looms vary in width from 38-inch reed space to about 90 inches. The looms weaving luster dress fabrics (mounted with a 300 Jacquard) and worsted serge have a speed ranging from 135 up to 145 picks per minute; the twilled cotton loom has a speed of 210 and the coating of 120 picks. The loom requires no more space or power than that requisite for the ordinary machine, while owing to its coming to a dead stop for interchange of shuttles, undue tear and wear to the change mechanism is prevented, so that excessive cost of repairs and renewals incidental to all looms which replenish weft while the loom is in motion are avoided. The loom contains fewer and stronger working parts, which require but little more attention from the tackler than an ordinary loom. Another important and conspicuous advantage is greater production; an average number of weft spools used in a day of ten hours is 120, and as each change takes but two and one-quarter seconds, the time spent in reshuttling is less than five minutes per day. Any kind and size of weft cops or spools may be used as with ordinary looms. It can be made either underpick or overpick, fast or loose reed, with any description of treading motion; and can be used as an ordinary one-shuttle loom at will if desired. No different reeds, healds, shuttles, pickers, etc., to those in use on ordinary looms are required.

From the point of view of attention, in one mill where a battery of 160 Hattersley automatic looms has been installed for a prolonged practical experiment, all of which are overpick with one exception which is underpick, one weaver has charge of 16 looms, and he is relieved of all work other than weaving purely and simply. The looms are supplied with two cloth beams so that when one is full the other comes into use, while a boy collects the full beams and carries them to the piece-room. The same boy takes the weft to the weaver, and has time also to act as reacher-in when required. Another operator is detailed to sweep and oil the looms. This point of attention to a number of looms, however, depends to a very great extent upon the quality of the raw material, and the desired quality of the woven goods. If breakages in the weft are very frequent, the number of looms allotted to one weaver must be decreased, while on the other hand if the faults are few and far between, it will be possible to increase the number of looms under one operator. This feature not only applies to the Hattersley loom, but to the Northrop as well, and in order that perfect comparative data on this question may be possible, Messrs. Hattersley are willing to have a public test of the utility of the Hattersley and Northrop looms on the understanding that each firm defrays its own expenses. Such a competitive trial would be both interesting and commercially valuable.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.



THE HATTERSLEY AUTOMATIC LOOM.

COLORING OF METALS.*

PROCESSES BY OXIDATION.

1. BY Heat: Coloration of Steel.—The steel, heated uniformly, is covered in the air with a pellicle of oxide and has successively the following colors: straw yellow, blue (250 to 300 deg. C.), violet, purple, water-green, disappearance of the color; then the steel reddens.

For producing the blue very readily, plunge the object into a bath of 25 parts of lead and 1 part of tin; its temperature is sufficient for bluing small pieces.

II. Bronzing of Steel.—The piece to be bronzed is wet by the use of a sponge with a solution formed of iron perchloride, cupric sulphate, and a few cubic centimeters of nitric acid. It is dried in the stove at 30 deg. C.; then kept for twenty minutes over boiling water. It is dried again at 30 deg. C. and rubbed with a scratch brush.

This operation is repeated several times.

III. Bronzing of Steel.—Rust and grease are removed from the objects with a paste of whiting and soda. They are immersed in a bath of dilute sulphuric acid and rubbed with very fine pumice-stone powder. They are then exposed from two to three minutes to the vapor of a mixture of equal parts of concentrated chlorhydric and nitric acids.

The object is heated to 300 deg. or 350 deg. C. until the bronze color appears. When cooled, it is covered with paraffine or vaseline while rubbing, and heated a second time until the vaseline or paraffine commences to decompose. The operation is repeated. The shades obtained are very beautiful, and the bronzing is not changeable. By subjecting the object to the vapors of the mixture of chlorhydric and nitric acids, shades of a light reddish brown are obtained. By adding to these two acids acetic acid, beautiful yellow bronze tints are procured. By varying the proportion of these three acids, all the colors from light reddish brown to deep brown, or from light yellow bronze to deep yellow bronze, are produced at will.

IV. Lustrous Black.—In a quantity of oil of turpentine, sulphuric acid is poured drop by drop, stirring continually until a precipitate is no longer formed. Then the whole is poured into water, shaken, decanted, and the washing of the precipitate commenced again until blue litmus paper immersed in the water is no longer reddened. The precipitate will thus be completely freed from acid. After having drained it on a cloth, it is ready for use. It is spread on the iron and burned at the fire.

If the precipitate spreads with difficulty over the metal, a little turpentine can be added. It is afterward rubbed with a linen rag, soaked with linseed oil, until the surface assumes a beautiful lustrous black. This covering is not liable to be detached.

V. Bronzing.—Under the name of Tuker bronze, a colored metal is found in trade which imitates ornamental bronze perfectly.

It is obtained by deoxidizing or, if preferred, by burnishing cast iron. A thin layer of linseed oil or of linseed oil varnish is spread on. It is heated at a temperature sufficient for producing in the open air the oxidation of the metal. The temperature is raised more or less, according as a simple yellow coloration or a deep brown is desired.

VI. Bluish Black.—Make a solution composed of nitric acid, 15 parts; cupric sulphate, 8 parts; alcohol, 20 parts; and water, 125 parts. Spread over the metal when well cleaned and grease removed. Dry and rub with linen rag.

VII. Black.—Make a solution composed of cupric sulphate, 80 parts; alcohol, 40 parts; ferric chloride, 30 parts; nitric acid, 20 parts; ether, 20 parts; water,

* From the French of M. Paul Malherbe, in La Revue des Produits Chimiques.

400 to 500 parts, and pass over the object to be blackened.

VIII. Magnetic Oxide.—A coating of magnetic oxide preserves very well from rust. To obtain it, submit the object in a furnace to a temperature sufficient to decompose steam. Then inject from four to six hours superheated steam at 600 deg. C. The thickness of the layer of oxide formed varies with the duration of the operation. This process may replace zincking, enameling, or tinning.

IX. Magnetic Oxide.—A deposit of magnetic oxide may be obtained by electrolysis. The iron object is placed at the anode in a bath of distilled water heated to 80 deg. C. The cathode is a plate of copper, or the vessel itself if it is of iron or copper. By electrolysis a layer of magnetic oxide is formed.

In the same way, other peroxides may be deposited. With an alkaline solution of litharge a brilliant black deposit of lead peroxide, very adherent, is obtained.

The employment of too strong a current must be avoided. It will produce a pulverulent deposit. To obtain a good coating, it is necessary after leaving the objects for a moment at the opposite pole, to place them at the other pole until the outside is completely reduced, then bring them back to the first place.

Browning of Magnetic Iron.—The protection of iron by covering it with a ferroso-ferric coating of oxide is recommended. A similar protecting coat may be obtained by heating the iron in the air after having covered it with linseed oil. The oxide is then mixed with charcoal. For objects not supporting a high temperature, they are allowed to remain in an acidulated solution of ferric chloride. A layer of ferroso-ferric oxide is then produced, which is rendered adherent by immersion in hot water, and rubbing, after desiccation, with linseed oil or wax.

PROCESSES BY SULPHURATION.

I. Oxidized Brown Color.—The object is plunged into melted sulphur mingled with lamp black, or into a liquid containing the flowers of sulphur mingled with lamp black. It is drained and dried. The bronzing obtained resists acids, and may acquire a beautiful polish, which has the appearance of oxidized bronze, due perhaps to the formation of ferric sulphide, a sort of pyrites remarkable for its beautiful metallic reflections and its resistance to chemical agents.

II. Brilliant Black.—Boil 1 part sulphur and 10 parts turpentine oil. A sulphurous oil is obtained of disagreeable odor. Spread this oil with the brush as lightly as possible, and heat the object in the flame of an alcohol lamp until the patina takes the tint desired. This process produces on iron and steel a brilliant black patina, which is extremely solid.

III. Blue.—Dissolve 140 grammes of sodium hyposulphite in 1,000 c.c. of water, and 35 grains of lead acetate in 1,000 c.c. of water. The two solutions mingled are heated to the boiling point. The iron is immersed, and assumes a blue coloration similar to that obtained by annealing.

DEPOSIT OF A METAL OR OF A NON-OXIDIZABLE COMPOUND.

I. Bronze Color.—Rub the iron smartly with chloride of antimony. A single operation is not sufficient. It is necessary to repeat it, heating the object slightly.

II. Black.—Make a paste composed of equal parts of chloride of antimony and linseed oil. Spread on the object, previously heated, with a brush or rag; then pass over it a coating of wax and brush it. Finally varnish with gum lac.

III. Black.—Make a solution of bismuth chloride, 10 parts; mercury chloride, 20 parts; cupric chloride, 10 parts; chlorhydric acid, 60 parts; alcohol, 50 parts; water, 500 parts. Add fuchsine in sufficient quantity to mask the color.

The mercury chloride is poured into the chlorhydric acid, and the bismuth chloride and cupric chloride added; then the alcohol. Employ this mixture with a brush or a rag for smearing the object. The object may also be immersed in the liquid, if it is well cleaned and free from grease. It is dried and afterward submitted to boiling water for half an hour. The operation is repeated until the wished-for tint is obtained; then the object is passed into the oil bath and taken to the fire without wiping. The object may also be placed for ten minutes in boiling linseed oil.

IV. Brown Tint.—A solution is made of mercury chloride, 20 parts; cupric chloride, 10 parts; chlorhydric acid, 60 parts; alcohol, 50 parts; water, 500 parts. The object is plunged into this solution after being well cleaned. The solution may also be applied with a brush, giving two coats. It is afterward put into hot water. The surface of the object is covered with a uniform layer of vegetable oil. It is placed in a furnace at a high temperature, but not sufficient for carbonizing the oil.

The iron is covered with a thin layer of brown oxide, which adheres strongly to the metal, and which can be beautifully burnished, producing the appearance of bronze.

V. Brilliant Black.—The process begins by depositing on the object, perfectly clean and free from grease, a layer of metallic copper. For this purpose the following solutions are prepared: (a) Cupric sulphate, 1 part; water, 16 parts. Add ammonia until complete dissolution. (b) Chloride of tin, 1 part; water, 2 parts, and chlorhydric acid, 2 parts. The object is immersed in solution b, and afterward in solution a. In this way there is deposited on the iron a very adherent coating of copper. The object, washed with water, is afterward rubbed with sulphur, or immersed in a solution of ammonium sulph-hydrate. A dull black coating of cupric sulphide is produced, which becomes a brilliant black by burnishing.

VI. Blue Black.—The iron object is heated according to the previous receipt, but the copper is converted into cupric sulphide, not by a sulph-hydrate, but by a hyposulphite. It is sufficient to dip the coppered object into a solution of sodium hyposulphite, acidulated with chlorhydric acid, and raised to the temperature of 80 deg. or 90 deg. C.

Thus a blue-black coating is obtained, unchangeable in air and in water. After polishing, it has the color of blue steel. It adheres strongly enough to resist the action of the scratch-brush.

VII. Deposit of Molybdenum.—Iron is preserved from rust by covering it with a coating of molybdenum as follows: water, 1,000; ammonium molybdate, 1 grain; ammonium nitrate, 15 to 20. Suspend the objects at the negative pole of a battery. The current ought to have an intensity of 2 to 5 amperes per cubic decimeter.

VIII. Deposit of Manganese Peroxide.—The iron or steel is covered with a coating of manganese peroxide by immersing as an anode in a bath containing about 0.05 per cent of chloride or sulphate of manganese and from 5 to 25 per cent of ammonium nitrate. The bath is electrolyzed cold, making use of a cathode of charcoal. Feeble currents (1 or 2 amperes) produce an adherent and unchangeable deposit.

IX. Bronzing of Cannon.—Make use of a solution of ferric chloride of density 1.281, 14 parts; mercury chloride, 3 parts; fuming nitric acid, 3 parts; cupric sulphate, 3 parts; water, 80 parts. Give to the piece of ordnance two or three coatings of the solution, taking care to always scratch the preceding layer with a steel brush before spreading the second. Afterward, the object is plunged in a solution of potassium sulphide in 900 parts of water. It is left in this for ten days. It is removed by washing with soap and hot water. The object is rinsed, dried, and finally brushed with linseed oil varnish.

X. Green Bronzing.—Dissolve one part of silver acetate in 20 parts of essence of lavender; coat the surface of iron with this liquid by means of a brush and raise the temperature to 150 deg. C. A brilliant green color is developed on the surface.

XI. Coating on Steel Imitating Gilding.—The object is covered by the galvanic method by means of a solution of cyanide of copper and potassium, then covered electrolytically with a thin deposit of zinc. It is dried and cleaned with a little washed chalk and finally immersed in boiling linseed oil. The surface of the piece after a few seconds, at a temperature of 160 deg. C. appears as if there had been a real penetration of copper and zinc; that is to say, as though there were a formation of tombac.

XII. Bronzing of Cast-iron.—The piece, when scraped, is coppered with the following bath; cupric chloride, 10 parts; chlorhydric acid, 80 parts; nitric acid, 10 parts. It is rubbed with a rag and washed with pure water, and then rubbed with the following solution: ammonium chlorhydrate, 4 parts; oxalic acid, 1 part; water, 30 parts.

XIII. Gilding of Iron and Steel.—Chloride of gold is dissolved in oil of turpentine or in ether, and this solution is applied with the brush on the metallic surface, after being perfectly scraped. It is allowed to dry, and then heated more or less strongly for obtaining the necessary adherence. When it is dry the gilding is burnished.

PROCESS BY DEPOSIT OF A COLOR OR VARNISH.

Beautiful colorations, resistive to light, may be given to metals by the following method:

The metallic objects are immersed in a colorless varnish with pyroxyline, and dried in a current of hot air at 80 deg. C. When the varnish is sufficiently dry, the objects are bathed for a few minutes in a two per cent alcoholic solution of alizarine or of a color of the same group. By washing with water the yellowish color covering the object on coming from the coloring bath passes to the golden red.

THE SCHROEDER CONTACT PROCESS OF SULPHURIC ACID MANUFACTURE.*

I. HISTORY AND COMMERCIAL DEVELOPMENT.

By DR. FRANZ MEYER.

IN 1884 the German Patent Office granted a patent to Emil Haenisch and Max Schroeder on a process for making anhydrous liquid sulphurous acid. The inventors were at that time connected with the zinc works of Giesches Erben in Upper Silesia, and thus they were aware of the difficulty which the disposal of the kiln gases offered to the German zinc smelters.

The problem of roasting the blende in such a manner that the gases could be utilized for the chamber process had already been solved by the furnace constructions of Hasenclever and Liebig-Eichhorn, but the great hopes entertained by the zinc smelters in this invention were not realized, as the many lead chambers built at the same time in connection with blende roasting plants caused a temporary overproduction of sulphuric acid. Schroeder and Haenisch thought to overcome this unfortunate situation of the acid market by utilizing kiln gases for other purposes, and the result of their efforts in this direction was the sulphurous acid process. Plant for operating this process on a large scale was erected in 1886 by Wilhelm Grillo in Hamborn-on-the-Rhine, by Schlesische A.-G. für Zinc-Huetten-Betrieb in Lipine, Upper Silesia, and by the firm of Graf Guido Henckel von Donnersmarck in Guidotto-Huette, Upper Silesia; but the fact that the market for this product is limited was soon established, and the same reason which had caused the inventors to work out the sulphurous acid process, viz., overproduction, led them to invent their first process for manufacturing sulphuric acid by catalysis from liquid anhydro-sulphurous acid.

In 1875 Clemens Winkler† published the results of his researches on the production of sulphuric acid by platinum-contact; the manufacture of fuming sulphuric acid by similar means was taken up by several European firms in competition with Stark in Bohemia, who so far had had the monopoly of this product. However, it was soon found that by the Winkler process the acid could not be made as cheaply as was hoped at first, the production of a mixture of sulphurous acid and oxygen by decomposing sulphuric acid by heat offering many disadvantages. Haenisch and Schroeder were in a position to manufacture this mixture of sulphurous acid and air cheaply, in any desired proportion, from their liquid sulphurous acid, and they induced the Badische Anilin und Soda Fabrik to try sulphurous acid made at Hamborn. These experiments were soon abandoned. Then the firm Wilhelm Grillo took the matter up with Haenisch and Schroeder, and after the inventors had proved in the laboratory that from a mixture of their sulphurous acid and air, sulphuric acid could be made with a high yield and good efficiency of the platinum used, an experimental plant for developing this invention was erected (see German patent No. 42,215). As this process is described in Lunge's handbook on the sulphuric acid industry, it will only be outlined here.

Heavy wrought-iron tubes 6 inches in diameter and 13 feet in length, are filled alternately with a layer of small stones and tightly packed platinized asbestos, each layer about three inches thick. Each tube contained about 15 of these double layers. One end of the tube was left empty to serve as a pre-heater for the gas mixture. These tubes were put in a furnace horizontally so that the empty ends were placed above the grate while that part which contained the platinum asbestos was situated on the other side of the fire bridge. The temperature of the furnace was kept at an average of about 400 deg. C., while a mixture of about 1 volume of sulphurous acid and 3 volumes of air was forced through the tubes by means of a compressor. This machine had two cylinders, the dimensions of which were in the proportion of 1 to 3. The suction of the smaller cylinder was connected with the upper part of a vessel containing the liquid sulphurous acid, while the larger cylinder drew filtered air. The discharge pipes of the two cylinders were connected, and thus sulphurous acid and air were mixed automatically in the desired proportion. The anhydride formed in the tubes was absorbed from the cooled gas by sulphuric acid.

The results obtained by this process were very satisfactory from the beginning, both as to yield and capacity, as a plant with five tubes had a daily output of about two metric tons of anhydride at a yield of 95 per cent of the theory. Two plants out of the five installed to operate the process are still working with liquid sulphurous acid. About three years ago one of these at the alizarine works of Carl Neuhaus in Eberfeld, working with the same platinized asbestos which was filled in the tubes when the plant was started in 1890, still gives the same high yield of about 95 per cent of theory. This proves that the catalytic action of platinum continues indefinitely if pure gases are used.

In German patent No. 42,215 the inventors claim the use of a higher pressure than that needed for overcoming the resistance in the tightly-packed contact tubes in order to bring the molecules of sulphuric acid and oxygen more closely together. This, however, was abandoned as soon as it was found that the pressure necessary for overcoming the resistance of the contact material (about 12 pounds to the square inch) was sufficient to yield about 95 per cent of the theory.

The good results obtained in the experimental plant in Hamborn caused the Badische in 1887 to enter upon a ten years' agreement with the owners of the patent, by which they obtained the right to use the process at a royalty, the firm, Wm. Grillo, binding themselves not to manufacture anhydride on a larger scale than 0.3 metric ton per diem during this period. The payment of royalties was discontinued in May, 1894, at which time the Badische manufactured about 10 metric tons of anhydride per day. Further developments of the Schroeder process at the works of the Badische were described by R. Knietsch in a paper read before the Deutsche Chemische Gesellschaft (see Jour. Soc. Chem. Ind., 1902, 172). The main improvement was the replacement of the pure sulphurous acid by the cheaper roasting gases.

In Hamborn it was soon found that the restrictions in output of the plant were such that they did not allow the further development of the process; hence the small plant was abandoned. When the agreement with the Badische expired in 1897, Schroeder had to take up his work where he had left it 10 years before. Haenisch had in the meantime parted from Schroeder, and all further improvements of the process in Hamborn were carried through by Schroeder in connection with the A.-G. für Zinc Industrie vorm. Wm. Grillo.

Further investigations were undertaken with a view to cheapen the process by utilizing the roasting gases directly and by reducing the resistance of the contact material. Both requirements are fulfilled by the contact material (U. S. patents No. 636,924 and No. 636,925). In this mass Schroeder replaces the insoluble bodies used heretofore as carriers for the platinum, as for instance, asbestos, pumicestone, burnt clay, etc., by calcined soluble salts, principally sulphates, in this way obtaining the following advantages:

1. The contact mass is easily regenerated, hence the kiln-gases do not need to be purified as perfectly as if working with platinized insoluble vehicles.

2. The calcined salt crusts are very porous, so that the contact mass made from them offers much less resistance to the gases passing through them than the tightly-packed asbestos used formerly.

3. The catalytic action of the contact mass made from soluble salts is far superior to that of platinized insoluble carriers, and the contents of the platinum in the contact mass, which were from 8 to 10 per cent of the weight of the asbestos in the old Schroeder plants, have been decreased to 0.1 per cent without reducing the efficiency of the contact material.

In working the plant, which was erected in Hamborn in 1898, for converting the sulphurous acid of the blende gases into sulphuric anhydride by means of the new contact mass, Schroeder soon discovered that he could reduce the resistance in the system still further by increasing the area of the contact tubes. The furnace, therefore, was supplied with tubes of 12 inches diameter instead of those of 6 inches diameter used in his old process. But in starting these tubes the yield dropped. The reason of this was found to be that on top of the contact mass in the tubes a channel was formed through which a part of the gases passed, as this way offered less resistance to them than the part of the tubes filled with contact material. To remedy this trouble the tubes were placed on an incline in the furnace, but even then they had to be opened from time to time to fill in any channels which had formed on top of the contact mass. It was, therefore, decided at Hamborn to replace the inclined tubes by an upright receptacle, and, as the increase of the diameter did not seem to have any bad effect upon the yield, a vessel of about 4 feet in diameter was chosen, which the gases, pro-

* Read before the Society of Chemical Industry.

† See also Squire, W. S., Eng. Pat. No. 3278, September 18, 1875, anterior to Winkler's publication.

heated in a separate apparatus, entered at the bottom. The walls and the top of the cylinder were well protected against radiation of heat. Nevertheless, a yield of only 85 to 90 per cent of theory could be obtained by this apparatus. The reasons for this insufficient yield were discovered by tapping the shell of the vessel and by analyzing gas samples taken from the center and from the surface of the contact mass in the vessel. In this way it was shown that the sulphurous acid in the gas, passing through the interior of the mass, was almost entirely converted into anhydride, while the gas next to the shell was only partly oxidized, due to the loss of heat at the walls. This difficulty was overcome by dividing the vessel into several compartments, and by placing plates of iron with a central hole underneath the screens that carry the contact mass. Thus the gases by passing through the comparatively narrow hole in the partition were thoroughly mixed before entering a new layer of contact mass. The same effect was also produced by placing several shallow vessels, each containing only one layer of contact mass, in series, and mixing the gases by passing them through the comparatively narrow tubes connecting the vessels with each other. The pressure necessary for forcing the gases through the contact mass has thus been reduced to less than one pound per square inch, so that in many of the Schroeder plants rotatory blowers are used for moving the gases instead of compressors.

There is not much to be said regarding the development of the methods and apparatus for purifying the roasting gases, and for absorbing the sulphuric anhydride from the contact gases. As already stated, the regeneration of the contact mass is so easily done, that an absolute purification of the roasting gases is not aimed at. Towers of large diameter filled with coke and sprayed with sulphuric acid have been in most cases found sufficient for purifying the gases. In America asbestos filters are used in addition, especially where the ore contains large quantities of arsenic. These filters were patented by George C. Stone, United States patent No. 711,187. The gases coming from the contact furnaces are cooled and then absorbed by passing over or through sulphuric acid of proper strength contained in iron apparatus.

There are already 14 plants in operation with a daily output of about 140 metric tons of sulphuric anhydride, i. e., 200 short tons of 66 deg. B. acid, as well as eight designed for a daily production of 100 metric tons of anhydride per diem in construction.

From the above it will be seen that the process is even to-day an important factor in the chemical industry of the world. In connection with this it is of interest to note that the credit for the first commercial production of sulphuric acid by catalysis, as well as for the rapid development and wide distribution of the present Schroeder process, is due to the progressive policy of a metallurgical industry whose interest in the matter was confined primarily to the utilization of a by-product.

(To be continued.)

PRESERVATION OF WOOD.

1. An excellent way of preserving wood is to cut it between August and October. The branches are removed, leaving only the leaves at the top. The trunks, carefully cut or sawn (so that their pores remain open), are immediately placed upright, with the lower part immersed in tanks three-quarters filled with water, into which three or four kilogrammes of powdered cupric sulphate per hectoliter have been introduced. The mass of leaves left at the extremity of each trunk is sufficient to cause the ascent of the liquid by means of the capillary force and a reserve of energy in the sap.

2. Wood which can be well preserved may be obtained by making a circular incision in the bark of the trees a certain time before cutting them down. The woodcutters employed in the immense teak forests of Siam have adopted in an empirical way a similar process, which has been productive of good results. The tree is bled, making around the trunk, at the height of 1.20 meters above ground, a circular incision 20 centimeters wide and 10 centimeters deep, at the time when it is in bloom and the sap rising. Sometimes the tree is left standing for three years after this operation. Frequently, also, a deep incision reaching the heart is made on two opposite sides, and then it takes sometimes only six months to extract the sap.

It is probable that it is partly in consequence of this method that the teak-wood acquires its exceptional resistance to various destructive agents.

3. A good preservation of piles, stakes, and palisades is obtained by leaving the wood in a bath of cupric sulphate of 4 deg. of the ordinary acidimeter for a time which may vary from eight to fifteen days, according to greater or less dryness of the wood and its size. After they are half dried they are immersed in a bath of lime-water; this forms with the sulphate an insoluble compound, preventing the rain from dissolving the sulphate which has penetrated the wood. This process is particularly useful for vine props and the wood of white poplars.

A good way to prevent the decay of stakes would be to plant them upside down; that is, to bury the upper extremity of the branch in the ground. In this way, the capillary tubes do not so easily absorb the moisture which is the cause of decay.

It frequently happens that for one or another reason, the impregnation of woods designed to be planted in the ground, such as masts, posts, and supports, has been neglected.

It would be impracticable, after they are placed, to take up these pieces in order to coat them with carbolineum or tar, especially if they are fixed in a wall, masonry, or other structure. Recourse must be had to other means. Near the point where the piece rises from the ground, a hole about one centimeter in width is made in a downward slanting direction, filled with carbolineum, and closed with a wooden plug.

It depends upon the consistency of the wood whether the liquid will be absorbed in one or two days. The hole is filled again for a week. The carbolineum replaces by degrees the water contained in the wood. When it is well impregnated, the hole is definitely closed with a plug of wood, which is sawn level with the opening. The wood will thus be preserved quite as well as if it had been previously coated with carbolineum.

4. Wooden objects remaining in the open air may be effectually protected against the inclemency of the weather by means of the following coating: Finely powdered zinc oxide is worked into a paste with water and serves for whitewashing walls, garden fences, benches, and other wooden objects. After drying, probably at the end of two or three hours, the objects must be whitewashed again with a very dilute solution of zinc chloride in glue or water.

Zinc oxide and zinc chloride form a brilliant, solid compound, which resists the inclemency of the weather.

As a paint for boards, planks for covering greenhouses, garden-frames, etc., Inspector Lucas, of Reutlingen (Würtemberg), has recommended the following coating: Take fresh cement of the best quality, which has been kept in a cool place, work it up with milk on a stone until it is of the consistency of oil-paint. The wood designed to receive it must not be smooth, but left rough after sawing. Two or three coats are also a protection from fire. Wood to be thus treated must be very dry.

5. The preservation of wood may be obtained by means of an injection of zinc chloride of 3 deg. Baumé. This process is applied in Germany, England, Austria, Denmark, Holland, and Russia. The solution is injected *in vacuo* under a pressure of eight atmospheres, in all 250 kilogrammes of liquid per cubic meter of wood. This process has, however, been found not to give as good results as injection with creosote.

6. The Boucherie process consists in the injection of a copper salt.

7. Some paving contractors treat wood with steam, in a vacuum, and inject a solution of copper sulphate under a pressure of twelve kilogrammes.

8. In the process of Dr. Penières, adopted in Paris, the wood is first submitted *in vacuo* with eight or ten cubic meters of mercury, then injected under a pressure of 6.500 kilogrammes with a solution containing the following per liter of water: iron sulphate 4 grammes, copper sulphate 2 grammes, zinc sulphate 2 grammes. The absorption is about 270 liters of water per cubic meter, very nearly 2.150 kilogrammes of salts. After this first preparation, the timber is piled up and exposed to the air for about a month; then it receives, as in the first operation, *in vacuo* and under pressure, an injection of sodium ferrocyanide (about 100 liters per cubic meter in the proportion of 6 to 12 grammes per liter). This double preparation generates in the ligneous tissues insoluble precipitates of ferrocyanide of iron (characterized by a gray-blue coloration), copper, and zinc; neutral and antiseptic precipitates. But this process is nearly twice as expensive as the ordinary process with sulphate; it costs about 9 or 10 francs per cubic meter, without counting the expense of transportation.

9. Certain researches of English engineers seem to show that wood treated with creosote resists the attacks of marine animals, such as the teredo. This appears from tests in the port of Great Yarmouth. Elm, beech, and fir absorb creosote very readily, provided the wood is sound and dry. Beech wood absorbs it the best. In fir the penetration is complete, when the wood is of a species of rapid growth, and of rather compact grain. Besides, with the aid of pressure it is always possible to force the creosote into the wood. It is stated that pieces of wood treated with creosote have resisted for ten or eleven years under conditions in which oak wood not treated in this way would have been completely destroyed.

The prepared wood must remain in store at least six months before use. The creosote becomes denser during this time and causes a greater cohesion in the fibers. In certain woods, as pitch pine, the injection is impossible, even under pressure, on account of the presence of resin in the capillary vessels.

10. M. Zironi, of Milan, advises to heat the wood *in vacuo*. The sap is eliminated in this way. Then the receiver is filled with resin in solution with a hydrocarbide. The saturation takes place in two hours, when the liquid is allowed to run off, and a jet of vapor is introduced, which carries off the solvent, while the resin remains in the pores of the wood, increasing its weight considerably.

11. The following treatment is particularly applicable to pine and spruce. After the wood has been dried perfectly in the furnace, it is placed in a receiver containing lime water and sulphuric acid. The cylinder is hermetically sealed and submitted to strong pressure, in order to secure a good penetration of the liquid. It is once more dried. The sulphuric acid and the lime produce an incrustation capable of protecting the wood against moisture, insects, and even (though in a slight degree) against fire. This process has also the advantage of being inexpensive.

12. Wood is well preserved when covered with a layer of lime or soaked in lime water for a week.

13. Wood can be well preserved by impregnating it with a solution of tannate of ferric protoxide. This method is due to Hazfeld.

14. We have previously described the Hasselmann process and that of Karl Petrascheek and the vulcanization process. It may be added that the Hasselmann process (xylolized wood), which consists in immersing the wood in a saline solution kept boiling under moderate pressure, the liquid containing copper and iron sulphates (20 per cent of the first and 80 per cent of the second), as well as aluminium and kainit, a substance until recently used only as a fertilizer, is now much employed on the railways in the south of Germany, and in the timberyards of Pittlak of the Xylosita Company, of Croydon.

15. Recently the discovery has been made that wood may be preserved with dissolved betuline, a vegetable product of the consistency of paste, called also birch-wood rosin. Betuline must first be dissolved. It is procurable in the crude state at a low price. The wood is immersed for about twelve hours in the solution, at a temperature of from 14 to 16 deg. C.

After the first bath the wood is plunged into a second, formed of a solution of pectic acid of 40 to 45 deg. Baumé, and with a certain percentage of an alkaline carbonate—for instance, potassium carbonate of commerce—in the proportion of one part of carbonate to about four parts of the solution. The wood remains immersed in this composition for twelve hours; then it is taken out and drained from eight to fifteen hours, the time varying according to the nature of the wood and the temperature. In consequence of this second bath, the betuine, which was introduced through the first immersion, is fixed in the interior of the mass. If it is desirable to make the wood more durable and to give it special qualities of density, hardness and elasticity, it must be submitted to strong pressure. In thus supplementing the chemical with mechanical treatment, the best results are obtained.

16. The electric methods of MM. Nodon and Bretonneau for the senilization or artificial aging and fireproofing of wood have been already described in our former issues.

Notwithstanding the various solutions of the interesting problem of the preservation of wood which we have passed in review, investigators are continuing their researches.

A manufacturer of Milan has founded an establishment for the application of a new method. This is based on the following principle, which we find developed in the Bulletin de la Société des Ingénieurs Civils and in the Bulletin de la Société des Ingénieurs et Architectes Italiens.

A receiver of any form or dimensions is filled with a fluid whose boiling point is above 100 deg. C., such as heavy tar-oil, saline solutions, etc. This is kept at an intermediate temperature varying between 100 deg. and the boiling point; the latter will not be reached, but if into this liquid a piece of wood is plunged, an agitation analogous to boiling is manifested, produced by the water and sap contained in the pores of the wood. These, under the action of a temperature above 100 deg., are dissolved into vapor and traverse the bath.

If the wood is left immersed and a constant temperature maintained until every trace of agitation has disappeared, the water in the pores of the wood will be expelled, with the exception of a slight quantity, which, being in the form of vapor, represents only the seventeen-hundredth part of the original weight of the water contained; the air which was present in the pores has been likewise expelled.

If the liquid is left to cool, this vapor is condensed, forming a vacuum, which is immediately filled under the action of the atmospheric pressure. In this way the wood is completely saturated by the contents of the bath, whatever may be its form, proportions or condensation. So far, the process differs but slightly from other methods employed in France, Belgium, and the United States.

To attain the desired effect it is not necessary to employ heavy oils. The latter have, however, the advantage of leaving on the surface of the prepared pieces a kind of varnish, which contributes to protect them against mold, worms, moisture, and dry rot. The same phenomenon of penetration is produced when, without letting the wood grow cold in the bath, it is taken out and plunged immediately into a cold bath of the same or of a different kind. This point is important, because it is possible to employ as fluids to be absorbed matters having a boiling point below 100 deg. and differing in this respect from the first bath, which must be composed of a liquid having a boiling point above 100 deg.

If, instead of a cold bath of a homogeneous nature, two liquids of different density separated in two layers, are employed, the wood can, with necessary precautions, be immersed successively in them, so that it can be penetrated with given quantities of each. Such liquids are heavy tar-oil and a solution of zinc chloride of 2 to 4 deg. Baumé. The first, which is denser, remains at the bottom of the vessel, and the second above. If the wood is first immersed in a saline solution, it penetrates deep into the pores, and when finally the heavy oil is absorbed, the latter forms a superficial layer, which prevents the washing out of the saline solution in the interior, as well as the penetration of moisture from the outside.

Such is the principle of the Glussani process; if this principle is not new, it is at least applied in an ingenious form and is calculated to produce advantageous effects.

Numerous experiments have been made with all kinds of wood, even with hard oak. In the preparation of oak railway ties for use on the road north of Milan it was discovered that pieces subjected to a temperature of 100 deg. in a bath of heavy tar-oil for four hours lost from 6 to 7 per cent of their weight, represented by water and albuminous substances, and that they absorbed in heavy oil and zinc chloride enough to represent an increase of from 2 to 3 per cent on their natural original weight. The oak wood in question had been cut for more than a year and was of a density of 1.04 to 1.07.

This system offers the advantage of allowing the absorption of antiseptic liquids without any deformation of the constituent elements of the wood, the more as the operation is performed altogether in open vessels. This fact has been demonstrated by means of photographs of cut wood injected according to the Rütgers method and according to the Glussani system. With the latter no alteration of the different layers of wood occurred.

Another advantage is the greater resistance of the wood to warping and bending, and to the extraction of metallic pieces, such as nails, cramp-irons, etc. This is attested by certificates obtained at the Royal School of Agriculture at Milan, where it has been proved that oak wood injected after the Glussani method presented a resistance 15 per cent greater than beech wood injected with zinc chloride after the Rütgers process.

The method is simple, inexpensive, easy to manipulate, and appears likely to come into extensive use. —Translated from La Chronique Industrielle.

Orders have been given to a Glasgow firm for the construction of locomotives for Canada. Colonial Secretary Chamberlain is responsible for the statement that they could not have been obtained without the operation of the preferential tariff between Canada and England.

THE MAGNETIC OBSERVATORIES OF THE UNITED STATES COAST AND GEODETIC SURVEY IN OPERATION ON JULY 1, 1902.*

By L. A. BAUER, Inspector of Magnetic Work, and J. A. FLEMING, Aid.

THE CHELTENHAM OBSERVATORY.

THE United States Coast and Geodetic Survey has in operation, in conformity with the plan of the magnetic survey of the United States and countries under its jurisdiction, outlined in Appendix 10, Report of the Superintendent of the Coast and Geodetic Survey for 1899, four magnetic observatories at which the manifold variations of the earth's magnetism are being continuously recorded by photographic means. These continuous records, besides serving other useful purposes, are utilized in referring the values of the magnetic elements, obtained at various stations and at various times by the field parties engaged in the magnetic survey, to a common time.

These four magnetic observatories, which constitute at present the primary magnetic base stations of the magnetic survey of the United States and countries under its jurisdiction, are as follows:

1. The Cheltenham Magnetic Observatory, situated at Cheltenham, Md. 2. The Sitka Magnetic Observatory, situated at Sitka, Alaska. 3. The Honolulu Magnetic Observatory. 4. The Baldwin Magnetic Observatory, situated at Baldwin, Kans.

The selection of a suitable site for a magnetic observatory to be continuously and uninterruptedly in operation for a period of fifteen years, at least, is a most difficult matter in view of the rapid spread and development of electric car lines and electric power and lighting establishments. Nearly every prominent magnetic observatory over the entire globe has suffered more or less in recent years from stray industrial electric currents.

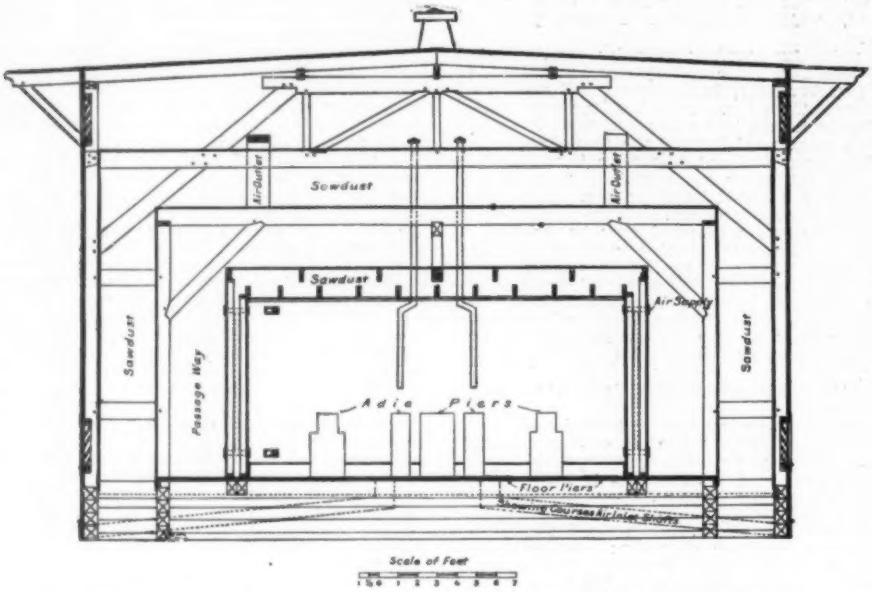
THE SITE OF THE CHELTENHAM MAGNETIC OBSERVATORY.

A number of sites within a radius of about 25 miles of Washington city, in Virginia and Maryland, were examined, and the distribution of the magnetic elements tested before the final location was decided upon. The problem of establishing a standard magnetic observatory, which is expected to have a life embracing the period necessary for the general magnetic survey of the United States, and which is to be within convenient reach of the office of the Coast and Geodetic Survey at Washington, required special care, and several months were accordingly spent before a decision was reached. As far as uniformity in distribution of magnetism was concerned, the magnetic survey of Maryland by L. A. Bauer, under the auspices of the Maryland Geological Survey, had already indicated that the region to the southeast of Washington would probably furnish the best site in this respect, and the additional examinations resulted in the selection of that region.

The site finally selected is on the grounds of the Maryland Reform School, about 1¼ miles west of the railroad station at Cheltenham, reached from Washington or Baltimore via the Pennsylvania Railroad, changing cars at Bowie to the Pope Creek Railroad, a single-track branch of the Pennsylvania system. The traffic on this branch consists of two local passenger trains in the morning, one in each direction; two similar trains in the afternoon; and an occasional local freight train. The grounds of the reform school embrace about 800 acres, and are surrounded on all sides by farms of large extent. The site leased by the Coast and Geodetic Survey for an indefinite number of years comprises nearly six acres, and is situated on the highest land between the Potomac and Patuxent rivers, the altitude being about 225 feet above sea level. Cheltenham consists principally of the buildings belonging to the reform school, about half a dozen frame cottages, two churches, and the railroad station.

CONSTRUCTION OF THE CHELTENHAM OBSERVATORY.

As a result of the first condition imposed above, the two structures, variation observatory and absolute observatory, consisting of an office flanked by two wings for the absolute observations, were built entirely of wood, and copper nails were used exclusively except when wooden pins could be substituted in framing. The greatest difficulty was found in selecting nonmagnetic material for foundations and piers, and ten samples of building stones were tested with the Adie magnetograph and all found more or less unsatisfactory. To overcome this difficulty, the foundations were designed to be 2½ feet deep of rubble work, surmounted by a grillage of 8 by 8 inch timbers, five pieces high. The materials were tested by bringing samples slowly within about five centimeters of an inclosed magnetometer needle, noting the change produced, and also noting the normal readings before and after samples were tested. The difference in readings sufficed to give a measure of the magnetic qualities of the sample in hand.



SECTION OF VARIATION OBSERVATORY, ADIE ROOM, CHELTENHAM OBSERVATORY.

Fortunately, at Cheltenham a marble was procurable practically free from magnetic properties. The foundations of the variation observatory and of the piers extending to the floor line were constructed of marble rubble work. Above the floor line some of the piers were built up to the desired height of cut marble pieces 12 and 8 inches thick, the separate pieces being doweled together with three five-eighths inch copper dowels set in plaster of paris. Other piers put in later are of sandstone, carefully tested. The instrument supports in the west wing of the absolute observatory were made temporarily of cedar posts of suitable heights inclosed with tongue and grooved casing and capped with hard wood blocks. In the east wing of the absolute observatory the instrument piers are of nonmagnetic sandstone.

The chimney for the office being fairly removed from observation centers, was designed to be of white brick which from tests was found to have a very small magnetic effect; a stone rubble construction would have been of inconveniently large section. For heating the office a wood stove of soapstone slabs was designed; this did not prove satisfactory and was replaced by a copper-covered stove lined with fire brick. The question of hardware furnishings was also a source of difficulty, as nearly all of the so-called "brass" fittings were found to have iron parts which made it necessary to place special orders for the greater part of this material.

The *second condition* made it preferable that the buildings for absolute and variation observations should be separate and distinct, though questions of practical convenience required that they be as close together as possible without danger of appreciable magnetic interaction between the various instruments. Rough calculations of the mutual actions between a C. G. S. magnetometer and the Adie instruments for varying intervening distances were made according to formulæ taken from an article by Professor von Wild. The effect was found to be practically zero, as the instruments were mounted 40 feet apart, and the plans were made accordingly. The two buildings were connected by a covered wooden corridor.

In fulfilling the *third condition* the general plan already used by the Coast and Geodetic Survey at San Antonio, Tex., seemed best to follow. This consisted in erecting two buildings for absolute determinations, attaching the same as wings on either side of the office and connecting them by passageways. The doors from the office to these wings and also the rear door of the west wing of the absolute observatory have glass panels, so that communication by signal, or otherwise, from one wing to the other and to parties in tents outside can be conveniently and readily made. The east wing of the absolute observatory has a bay window extension on the north side to accommodate the Wild-Edelmann observatory declinometer.

The *fourth condition* requires that either some sort of insulation be provided if the variation observatory be erected above ground, or that the general use of an underground construction be followed. The success in the matter of uniform temperature conditions attained at the Dutch observatory at De Bilt, as well as the generally unsatisfactory conditions prevailing in most underground observatories because of moisture encountered in such structures, confirmed the opinion that a building above ground could be built so as to satisfy temperature conditions as well, or nearly so, as an underground structure, and which would have, at the same time, the advantages of greater economy, convenience, and accessibility.

The choice of insulating packing for the walls was a question of prime consideration. The manufactured insulating materials on the market, on inquiry and examination, were found to contain more or less iron in their composition, and at the same time they would have involved a much greater cost than is permissible when used in such quantities as required. After a careful consideration of the non-magnetic materials available, carefully dried sawdust was decided upon as best adapted to the existing conditions.

The wall insulation of the variation observatory is as follows: Beginning at outside of building, pine weatherboarding, 8-ply building paper, 1-inch pine sheathing, 8-inch air shaft, 1-inch pine sheathing, 8-ply paper, 3 feet pine sawdust, 8-ply paper, seven-eighths inch pine ceiling, 3 feet, 2 inches air space of passageway, seven-eighths inch pine ceiling, 8-ply paper, 1 foot pine sawdust, 8-ply paper, seven-eighths inch pine ceiling. Slat ventilators of louver windows are so arranged and provided with closely fitting shutters that during the winter the 8-inch air shaft referred to can be made practically air-tight, while during summer when opened these tend to admit of the passage and circulation of a cooling draft around building. The insulation beginning at the roof and going down is: Gravel and asphalt pitch roof, 1-inch pine sheathing, 3 feet, 8 inches air space communicating with 8-inch air shaft around building and provided with six louver windows with close-fitting shutters as on those at the bottom of the air shaft, 1-inch rough pine floor, 3-foot filling of pine sawdust, 8-ply paper, seven-eighths inch pine ceiling, 3-foot air space above rooms, 1-inch rough pine floor, 1 foot, 6 inches pine sawdust, 8-ply paper, seven-eighths inch ceiling. Insulation from bottom of foundation is 2 feet, 8 inches of earth, 6-inch to 8-inch layer of screened gravel, about 3 feet pine sawdust, 1-inch pine under floor, 8-ply paper, seven-eighths inch pine tongue-and-groove floor.

The greatest difficulty in obtaining the desired results lay in the necessity of providing openings through the walls for the ventilation of the rooms and for the means of ingress and egress Four shafts, each 5 by 10 inches and about 16 feet long, furnish the

INSTRUMENTS FOR DETERMINING HORIZONTAL INTENSITY, CHELTENHAM MAGNETIC OBSERVATORY.

* From the Annual Reports of the Superintendent of the United States Coast and Geodetic Survey, 1903, to which we are indebted for the article and engravings.

air supply to the passageway, through wooden floor grates. These are provided with heavy rabbeted shutters made to fit very closely and fitted with refrigerator fasteners, so that they may be made air-tight. They are also provided at inlet with copper wire screens of double thickness to break force of wind blowing toward opening and to keep out such vermin as field mice. Ventilation of passageway is effected by four shafts opening into air space below the roof, each 6 by 10 inches and about 16 feet long, provided with close-fitting slides. Ventilation of air space below the roof is effected by three 14-inch copper "Star" ventilators. By the judicious use of these air ducts and ventilators, the danger of direct conduction of temperature changes through the shafts can be entirely eliminated. Ventilation of the magnetograph rooms from and into the passageway is effected in each room by four 3-inch square vertical shafts in the sawdust packing, having inlet or outlet just below the ceiling or above the baseboard, according to the arrangement of four closing slides provided for each. To carry off gases of combustion from the lamps of the magnetograph, 3-inch copper ventilators are provided.

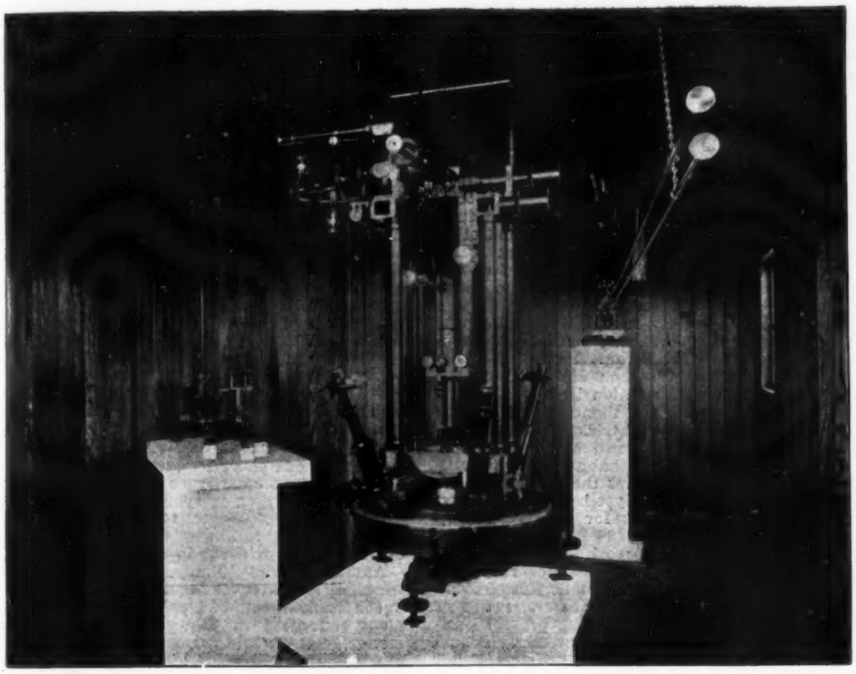
Entrance into the building proper is had through a vestibule on the south side, 10 feet by 13 feet, 8 inches outside dimensions. The walls of the entrance are built like those of the main building, without the air shaft and with only 2 feet of sawdust packing. The outside door can be closed before opening a second door in a small entrance hall, which is 6 feet wide and 11 feet long; from this room a third door leads into an opening in the sawdust packing, whence a fourth door opens into the passageway around the rooms. In placing these doors particular care was taken to make them close fitting. Entrance into either of the magnetograph rooms is to be had only from the hall between the two rooms through 8-inch refrigerator-patterned doors packed with sawdust.

The diurnal range of the temperature was thus reduced at Cheltenham to a matter of a few tenths of a degree, and, in fact, it is believed that even this small variation will be eliminated as soon as some other source of light than the present lamps has been introduced. It has been repeatedly found that any sudden change of temperature which may amount to 50 to 60 deg. F. outside only makes itself felt gradually inside, and then does not amount to much over 0.5 deg., and may even be less than this amount.

The annual range has been converted into a gradual progressive change, for which allowance can easily be made, and amounting to between one-half and one-third of what it would be outside.

The *fifth condition* imposed by the contemplated use of the Adie magnetograph as the eye-reading instrument and reserve magnetograph, made necessary two magnetograph rooms in the variation observatory, and that they be placed as far apart as economy of construction would permit. The rooms are each 16 feet by 19 feet, 6 inches, these dimensions giving ample space for the accommodation of the eye-reading Adie instruments in the south room, and for both the regular set of Eschenhagen self-registering instruments and a test set in the north room. The hallway between the two rooms is 5½ feet wide.

The following general statements are of interest: The outside dimensions of the variation observatory are 36 feet by 56 feet by 24 feet high, with entrance 10 feet by 13 feet. The outside dimensions of office are 18 feet by 22 feet, with two 5 feet by 7 feet passages leading to two wings for absolute observations, each 10 feet by 12 feet, thus making the total length of the absolute observatory, inclusive of the office, 60 feet. As already stated, the east wing of the absolute observatory has a bay window extension of 6 by 7½ feet on the north side. The materials used were about 90 tons of building marble for foundations and piers, 85,000 feet of lumber, a trifle over 1 ton of copper nails, and something more than 190 tons of sawdust and shavings for insulation. No satisfactory bid from contractors for erecting the buildings having been received, the construction was placed in the hands of the writer. The total cost of the buildings, including masonry and pier work, was something less than $6,900, which is $2,500 less than the lowest bid received. Some subsequent additions (piers, bay window, and covered corridor) have increased the cost about $500.



INSTRUMENT FOR DETERMINING ABSOLUTE DECLINATION AND INCLINATION, CHELTENHAM MAGNETIC OBSERVATORY.

EQUIPMENT OF THE CHELTENHAM MAGNETIC OBSERVATORY.

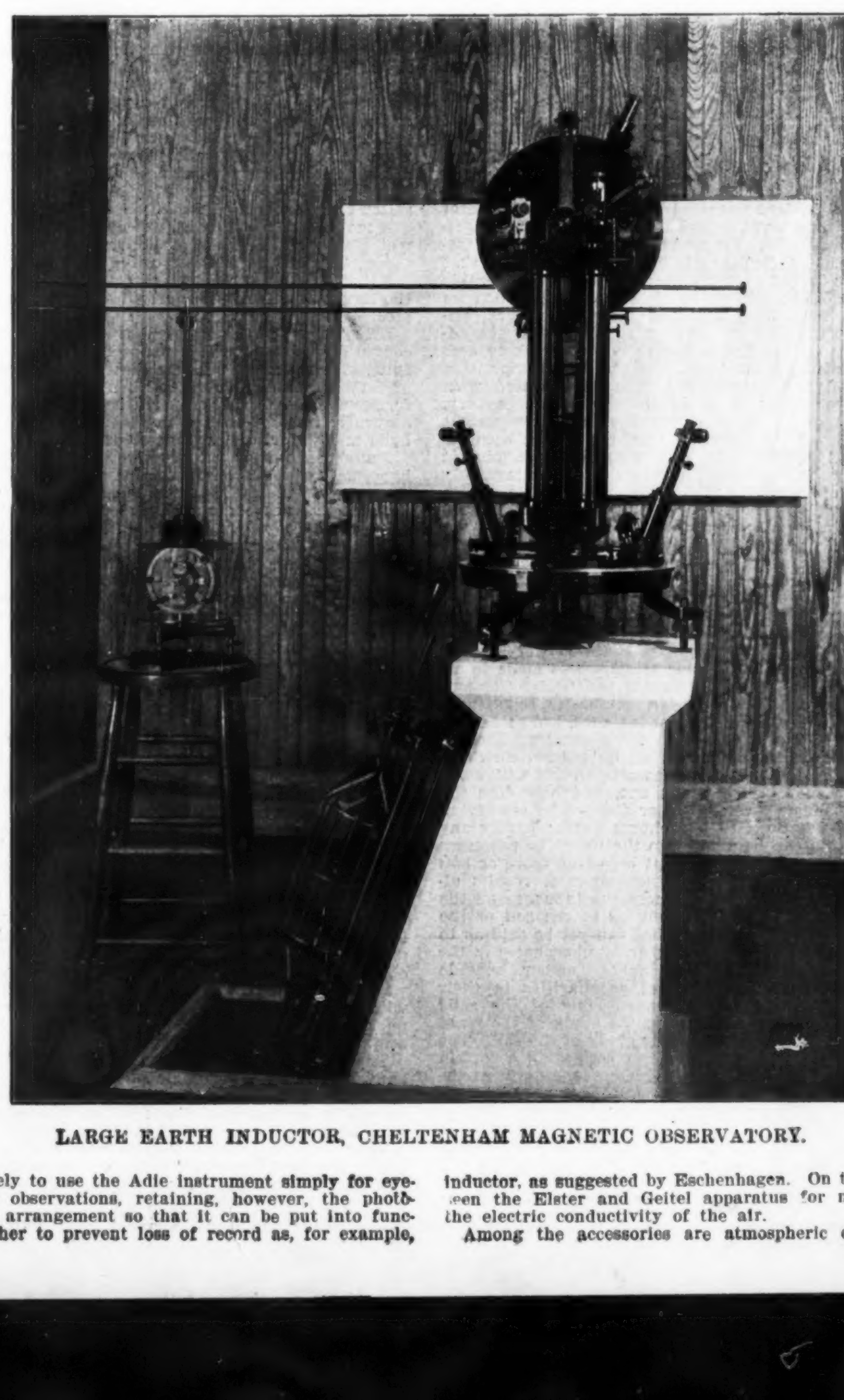
Variation instruments: Eschenhagen-Toepfer magnetograph as the principal photographic set and an Adie magnetograph formerly mounted at Los Angeles, Cal., from 1882 to 1889, and at San Antonio, Tex., from 1890 to 1895, this magnetograph having telescopes and scales for eye readings. It is the intention ultimately to use the Adie instrument simply for eye-reading observations, retaining, however, the photographic arrangement so that it can be put into function either to prevent loss of record as, for example, during adjustments of the Eschenhagen magnetograph, or for the purpose of obtaining, in special investigations, a duplicate record with a totally different instrument.

Absolute instruments: A large observatory Wild-Edelmann declinometer, earth inductor, and magnetometer, to determine, respectively, the declination, dip, and horizontal intensity, the instruments being always in place and ready for observations at any time. The declinometer, earth inductor, galvanometer, and large theodolite are mounted in the east wing of the absolute observatory, whereas the magnetometer for horizontal intensity observations (adapted also for secondary magnetic declination determinations with short magnet, when needed), is mounted in the west wing of the observatory. A set of field magnetic instruments also forms part of the outfit.

One of our illustrations gives a view of the instruments, obtained by looking north through the south window of the east wing of the absolute observatory. In the center is shown the large Wild-Edelmann theodolite having a horizontal and a vertical circle, each 30 centimeters in diameter, which with micrometer microscopes can be read directly to 2 seconds. The position of the magnet of the declinometer shown in the back of the picture on the right is observed with the aid of the telescope of the theodolite and read on the large horizontal circle, the observer performing all manipulations of the magnet, such as clamping and reversing it in its stirrup for the determination of the magnetic axis, from his position at the telescope, with the aid of the 12-foot long brass rods shown on the right. Behind the pier supporting the theodolite is mounted the earth inductor shown in the illustration, and on the pier to the left is the Rosenthal-Edelmann microgalvanometer and reading telescope with scale, used in connection with the earth inductor. The inclination of the axis of the inductor is obtained with the aid of the telescope of the theodolite and the angle is read by means of the micrometer microscopes on the large vertical circle. The same theodolite can be used for the determination of time, latitude, and azimuth if necessary.

One of our illustrations presents a view looking west from the office into the west wing of the absolute observatory. In the center is seen the large Wild-Edelmann magnetometer designed principally for determining the horizontal intensity; the horizontal circle of this instrument has likewise a diameter of 30 centimeters and is read with micrometer microscopes to 2 seconds. With the aid of these instruments the absolute elements are determined with the degree of accuracy requisite for the variation observations.

On the right of the picture is shown a smaller earth inductor made by Schulze, of Potsdam, embodying slight modifications upon the small Wild-Edelmann inductor, as suggested by Eschenhagen. On the left is seen the Elster and Geitel apparatus for measuring the electric conductivity of the air.



LARGE EARTH INDUCTOR, CHELTENHAM MAGNETIC OBSERVATORY.

Among the accessories are atmospheric electricity

instruments, meteorological instruments, two chronometers, thermographs, etc. In view of the fact that a Milne seismograph is now mounted at the Johns Hopkins University, Baltimore, about 40 miles from Cheltenham, the mounting of a seismograph at Cheltenham has been deferred temporarily. It is hoped soon to be able to install the necessary apparatus for earth-current observations, for which the Cheltenham site is admirably suited. It is the intention ultimately to carry out at this observatory all the work forming an essential part of a fully equipped, first-class magnetic observatory.

VEGETABLE PHYSIOLOGY.*

By Prof. J. Reynolds Green, M. A., Sc. D., F. R. S.

I can only attempt to deal with a small portion of the botanical field. These are the days of specialization, and when anyone is said to be a botanist, the question which arises at once is, Which particular section of botany is he associated with? The same principle of subdivision which cut up the old subject of Natural History into Zoology, Botany and Geology has now gone further as knowledge has increased, and three or perhaps four departments of botany must be recognized, each demanding as much study as the whole subject seemed to only fifty years ago. I shall therefore confine my remarks to-day to the field of vegetable physiology.

I should like at the outset to recommend this section of botanical work to those of the younger school of botanists who are contemplating original research. To my mind the possibilities of the living organism as such present a fascination which is not afforded by the dry bones of morphology or histology; valuable as researches into the latter are, they seem to me to derive their importance very largely from the past, from the possibility of indicating or ascertaining the line of descent of ancestors. The interest thus excited seems to me to be rather of an academic character when compared with the actual problems of present-day life, its struggles, triumphs and defeats in the conflict for existence waged to-day by every living organism. The importance of the study of physiology as bearing upon the problems of the morphologists has, I need hardly say, been fully recognized by the workers in that field. I may quote here a sentence or two from the Address of one of my distinguished predecessors, who said at Liverpool, "There is a close relation between these two branches of biology, at any rate to those who maintain the Darwinian position, for from that point of view we see that all the characters which the morphologist has to compare are, or have been, adaptive. Hence it is impossible for the morphologist to ignore the functions of those organs of which he is studying the homologies. To those who accept the origin of species by variation and natural selection there are no such things as morphological characters pure and simple. There are not two distinct categories of characters—a morphological and a physiological category—for all characters alike are physiological."

But apart from the considerations of the claims of vegetable physiology based upon its own intrinsic scientific value and the interest which its problems possess for the worker himself, and upon the place accorded to it as its relationship to morphology, it must, I think, be recognized as being of fundamental economic importance, especially in these times of agricultural depression. For many years now it has been recognized that agriculture is based upon science; that it involves indeed properly the application of scientific principles to the cultivation of the soil. But when we look back upon what has passed for agricultural science since the alliance between the two has been admitted, we cannot but recognize how lamentably deficient in breadth it has been. The chemical composition of the soil and subsoil has been investigated with some thoroughness in many districts of the country. The effect of its various constituents on the weight and quality of the crops cultivated in it has been exhaustively inquired into, and a considerable amount of information as to what minerals are advantageously applied to the soil in which particular plants are to be sown has been acquired. A kind of empirical knowledge is thus in our possession, in some respects a very detailed one, quantitative as well as qualitative records being available to the inquirer. But elaborate as have been the researches in these directions, and costly and troublesome as the investigations have been, they have been hardly, if at all, more than empirical. Till quite recently the physiological idiosyncrasies of the plants round which all these inquiries centered were almost entirely ignored. No serious attempt was made to ascertain the way in which a plant benefited by or suffered from the presence of a particular constituent of the soil. What influence, for instance, has potassium or any of its compounds upon the general metabolism of the plant? Does it affect all its normal nutritive processes, or does it specially associate itself with some particular one? If so which one, and how does the plant respond to its presence or absence by modifying its behavior? So with phosphorus again; hardly any investigation can be made into the nutritive processes of a plant without this element becoming more or less prominent. In some cases the empirical results already referred to show an enormous influence on the crop exerted by soluble phosphates in the soil or the manure applied to it. But what can yet be said as to the rôle played by phosphorus or by phosphates in the metabolic processes in the plant? Further, how do different plants show different peculiarities in their reactions to these various constituents of the soil? For the advance of agriculture the study of the plant itself must now be added to the study of the soil. The fact that it is a living organism possessing a certain variable and delicate constitution, responding in particular ways to differences of environment, capable of adapting itself to a certain extent to its conditions of life, dealing in particular ways with different nutritive substances, must not only be recognized, but must be the basis for the researches of the future, which will thus supplement and enlarge the conclusions derived from those of the past, in some respects correcting them, in others establishing them on a firmer basis.

In pressing upon the younger school of botanists the importance of this line of research, I do not wish to minimize the difficulties that accompany it. Difficulties of method assume considerable magnitude, for we have here no question of section cutting and microscopic examination. Vegetable physiology is allied very closely to other sciences, and research into its mysteries involves more than a preliminary acquaintance with them. Especially must one point out the importance, indeed the necessity, of acquaintance with a certain range of organic chemistry and with chemical methods of work. In certain directions, too, physics are as much involved as chemistry in others. The bearing of these sciences in particular directions will be referred to later.

I fear another obstacle stands at the threshold of research which looks sufficiently formidable. The so-called fundamental facts of vegetable physiology have been laid down with sufficient dogmatism in text-books by many writers whose names carry with them such weight that it appears almost heresy to question their statements. We have been content to accept many things on the authority of the great workers of the past, with the result that the advance of knowledge has been hindered by such acceptance of what were deemed facts, but were really inaccuracies. We may refer, for instance, to the statement made by Boussingault, and accepted by most botanists ever since his time, that the absorption of carbon dioxide from the air takes place by means of solution in the cuticle of the epidermal cells of plants and thence passes by diffusion to the seats of photosynthesis. Only comparatively recently has this been shown to be erroneous. If, however, it is once recognized that authority is fallible, this apparent obstacle becomes the opposite. The more evident questions have not yet been solved, leaving only the more difficult ones for the present-day worker.

Recognizing the importance of work in this field, and realizing that with the advent of a new century new departures must be taken, I have thought I might venture to direct the thoughts of my hearers, many of whom I may call my colleagues, to the present position of certain problems which have long been the subjects of speculation and which offer the prospect, if not of complete solution, at any rate of considerable advance if investigated by modern methods.

I turn first to a few questions connected with the nutritive problems of plants in general.

There are several theories abroad as to the progress of events during photosynthesis, none of which can be regarded as entirely satisfactory. For many reasons it seems desirable that this question shall be thoroughly investigated in the light of the present condition of both chemical and physical science. I may perhaps venture to recall to you the principal hypotheses of carbohydrate formation which have been advanced, so that its present position may be properly appreciated.

The view that has met with the widest acceptance is that of Baeyer. On his hypothesis the carbon dioxide absorbed is decomposed under normal conditions to yield carbon monoxide and oxygen; a corresponding and coincident decomposition of water leads to the production of free hydrogen and oxygen. The oxygen from both sources is exhaled, while the carbon monoxide and hydrogen combine to form formaldehyde. The formaldehyde gives rise by a process of polymerization to some form of sugar.

A modification of this hypothesis has been advanced, which suggests that the preliminary decomposition of the carbon dioxide and the water may not take place, but that by a rather less violent reaction between them the formaldehyde may be formed and the oxygen liberated.

Erlenmeyer has suggested a somewhat different course of reaction, yielding substantially the same results. He thinks it possible that the first interaction of carbon dioxide and water leads to the formation of formic acid and hydrogen peroxide, and that these subsequently interact with each other, yielding formaldehyde and water and giving off oxygen.

Many years after the views of Baeyer appeared, a hypothesis of a different nature was proposed by Crato. He suggests that the carbon dioxide after absorption becomes ortho-carbonic acid, and that this remains in solution in the cell sap. This acid has the structure of a closed benzene ring in which six molecules are linked together. This becomes decomposed, liberating six molecules of water and six molecules of oxygen, and forming a hexavalent phenol which subsequently undergoes a molecular rearrangement and becomes glucose.

Yet another suggestion was made by Bach in 1893. He points out that when sulphurous acid is exposed to light it becomes transformed to sulphuric acid, sulphur and water being split off, and he argues that a process analogous with this may take place in a leaf. The carbon dioxide uniting with water would form carbonic acid, and this might then split up in the same way as the sulphurous acid. The carbon and the water thus split off are on this hypothesis not set free separately, but in combination as formaldehyde. The higher carbon acid, to which Bach ascribes the formula H_2CO_4, splits up into carbon dioxide and hydrogen peroxide, and the latter is decomposed into water and free oxygen.

Lieben has still more recently put forward the view that formic acid and not formaldehyde is formed by the first decompositions. He has found that leaves of grasses and various trees yield formic acid among other products when mixed with their own weight of water containing a trace of sulphuric acid and distilled with steam. Moreover, when carbon dioxide is acted upon by nascent hydrogen the only product is formic acid.

These speculations afford many points which might be well made the starting places of research. The views of Baeyer have met with most acceptance, though but little success has attended the few efforts that have been made to establish them by experiment.

They involve several definite stages of action, of which the most important seem the production of carbon monoxide and hydrogen, the formation of formaldehyde, and the construction of a sugar. The last two questions arise also in connection with the hypothesis of Bach.

If we examine the work that has been published bearing on the probability of the formation of carbon monoxide in the plant we find little that is satisfactory. The statements that have been made are opposed to the idea that carbon monoxide is of value in nutrition; it is said that when supplied to a plant instead of carbon dioxide it does not lead to the formation of carbohydrates. It is further advanced that this gas is of a very deleterious nature, and if formed would result in the speedy death of the protoplasm of the cell in which it originates. This idea is, of course, specious; but it does not appear to be well founded. The deadly character of carbon monoxide when inhaled by a human being depends upon a peculiar interference which it causes with the oxygen-carrying power of the red blood corpuscles. The pigment hæmoglobin to which these little bodies owe their usefulness forms a loose chemical combination with oxygen, the compound being formed in the blood vessels of the lungs and being decomposed with the liberation of the oxygen in those of the tissues of the body. It is evident, therefore, that the value of the corpuscles as oxygen-carriers depends upon their hæmoglobin. When this pigment is exposed to carbon monoxide it combines with it in the same way as it does with oxygen, forming, however, a more stable compound. The affinity for this gas which the pigment manifests is very considerable. Hence the poisonous nature of carbon monoxide. It is easily seen that the latter is a poison because it throws out of gear and temporarily paralyzes a most essential part of the mechanism of respiration, effectually preventing oxygen from reaching the tissues of the body. There is no evidence here that it exerts even a deleterious influence upon the living substance itself. The only poisonous effect it would be able to exert on the plant would necessarily be of the latter character, for there is no oxygen-carrying mechanism that could be interfered with. We cannot lay any stress, therefore, on the objection to Baeyer's view, based upon the action of carbon monoxide upon the human organism.

Another possibility may, however, be mentioned. As we shall see later, there are certain resemblances between hæmoglobin and chlorophyl, the vegetable pigment concerned in photosynthesis. May not carbon monoxide enter into some relationship with the latter, and thereby indirectly hinder its activity? Of that, however, there is no trustworthy evidence, the facts known to us rather pointing in the opposite direction.

The idea of the poisonous nature of this gas may easily be subjected to experimental examination. It would appear easy to expose a plant to an artificial atmosphere made up to different partial pressures of carbon monoxide, to expose it in such atmospheres to various conditions of warmth and illumination and to note the effect produced. It would seem possible to examine a great variety of plants in that way, to try both aerial and aquatic forms, and indeed to test the matter exhaustively. It must be borne in mind, however, that the solubility of carbon monoxide in water is extremely small, and that there may be a great difficulty in getting it brought within the scope of the influence of the living substance on that account. It must necessarily be in solution in the cell sap before it can affect the activity of the chloroplast. Even the relations of solubility are not, however, outside the range of experiment, and it may be that the slightly acid cell sap has not the same peculiarities as water as a solvent for the gas.

It is important, again, to take into account in such work the factor of sunlight, on which the power of photosynthesis depends. Should carbon monoxide prove capable of serving as a basis for the formation of carbohydrates, the question would arise, Is the activity of the chlorophyl in sunlight confined to the preliminary formation of carbon monoxide from the dioxide, or is the energy derived from the light brought to bear upon the subsequent constructive processes? We have little or no accurate information as to the way in which the energy is utilized after absorption by the chlorophyl.

This opens up a very important but very difficult line of work, which brings home to us the intimate dependence of vegetable physiology upon physics. The absorption of energy from without, in the form of the radiant energy of the solar rays, is certainly a fact, and to a certain extent we can picture to ourselves the way in which it is secured. The spectrum of chlorophyl shows us a number of absorption bands whose position corresponds with the position in the spectrum of the places where oxygen is liberated in photosynthesis. But the transformation and applications of energy in the body of the vegetable organism need much closer examination. The intimate relationship between the different manifestations or forms of energy and the ways in which they can be transformed into one another have been very minutely scrutinized in recent times. What then should hinder us from learning something much more definite than we at present know about these transformations in the rôle of vegetable life? The electrical phenomena connected with the movements of the leaves of the Venus's fly-trap (*Dionæa muscipula*) have been examined with considerable completeness by Burdon Sanderson, and we have learned that the vegetable and animal organisms show considerable similarities in this respect. Recently, again, Bose has made important contributions to the subject of the electrical responses to stimulation that can be observed under particular conditions. A promising beginning has thus been made, but only a beginning. The electrical condition of the normal plant under different conditions of rest and activity has still to be investigated. If we return to the subject of photosynthesis and the work done by the chloroplast, may we not hope to discover something about the transformation and utilization of the radiant energy associated somehow with this structure? Considering the relations between the manifestations of energy which we appreciate respectively as light and electricity, it does not seem wildly improbable to imagine that the energy absorbed as the former may lead to a possible electrolysis of carbonic acid under the influence of the chloroplast, with the formation of carbon monoxide and oxygen. Pfeffer has suggested that perhaps the decomposition of the gas is not due to the light rays at all, and that they may exercise only a stimulating influence upon the chloroplast, the energy concerned being derived from heat rays directly absorbed, or heat vibrations derived from the more rapidly vibrating light rays. In this

* Read before the British Association for the Advancement of Science.

case is the decomposition brought about directly by the head vibrations, or have we a transmutation into some other form of energy? The whole subject seems at all events a promising subject for inquiry.

Another problem connected with the action of chlorophyl is associated with the absorption of radiant energy by the different regions of the spectrum. Bands of considerable intensity are noticeable in the blue and violet, though the deepest absorption takes place in the red. Yet Engelmann's classic bacterium method shows us that very little evolution of oxygen takes place in the position of these bands in the blue and violet. The fact that absorption of radiant energy and photosynthetic activity show no quantitative relationship is of course not new, but the reason remains still to be discovered. Van Tieghem has suggested an explanation which recalls to us the hypothesis advanced by Pfeffer, just alluded to. This explanation is that there are two factors concerned in the action of chlorophyl, the elective absorption of light, shown by the occurrence of the absorption bands in the spectrum, and the calorific energy of the absorbed radiations. The failure of the rays of the blue and violet to effect photosynthesis, in spite of their absorption, would on this view be attributable to their possessing but little calorific energy. The latter is associated much more strongly with the deep band in the red, which is the seat of the maximum evolution of oxygen when the spectrum is thrown upon a collection of active chloroplasts. The heating rays alone are ineffectual, as shown by the fact that there is no liberation of oxygen in the region of the infrared, due no doubt to the fact that chlorophyl does not absorb these rays.

Timiriazeff, in his classical researches on the liberation of oxygen by the leaves of the bamboo when exposed in tubes of small caliber to a large spectrum, found that the amount of carbon dioxide decomposed by leaves is proportional to the distribution of effective calorific energy in the spectrum.

Van Tieghem's hypothesis that this is a matter of calorific energy may prove to be erroneous, and yet his views may rest on some sound basis. It may be a matter in which electrical rather than calorific energy may be concerned.

Returning now to the chemical steps demanded by Baeyer's hypothesis, there are certain considerations which may be urged in favor of the view that carbon monoxide really occurs in photosynthesis. It has been ascertained by Norman Collie that when a mixture of gases containing a large proportion of carbon dioxide is exposed at low pressures in a vacuum tube to the action of an electric discharge from an induction coil, there is a very large formation of the monoxide, together with oxygen, in some cases as much as 70 per cent of the gas undergoing decomposition.

Appealing to the experience of various observers, there seems on the whole to be a balance of evidence in favor of the power of plants to live and prosper in an atmosphere containing a very considerable percentage of carbon monoxide.

The question of the possibility of the latter replacing the dioxide, as the theory appears to require, is complicated very seriously by the differences of solubility between them. Carbon dioxide dissolves very readily in water and in cell sap; carbon monoxide is almost insoluble in either. As the amount of a gas taken up by a solvent depends, not only on its solubility, but upon its partial pressure, it is very evident that we cannot compare the two gases by admitting the same quantity of both to plants under simultaneous comparison. It is only necessary to supply the dioxide in the proportion of four parts in 10,000; but the almost insoluble nature of the monoxide makes it inevitable that from 2 to 5 per cent shall be experimented with. The same question of solubility makes it almost out of the question to experiment with an aquatic plant.

It would be of considerable interest from this point of view also to inquire whether if carbon monoxide is liberated at the outset of the photosynthetic processes its combination with other groupings can take place apart from the action of chlorophyl. If so, the fungi should be capable of carbohydrate construction if supplied under proper conditions with the monoxide and with hydrogen. The proper conditions, however, might be extremely difficult to establish.

The next stage in the constructive process affords still ample room for investigation. The presence of formaldehyde is not the hypothesis of Baeyer alone, but is demanded according to Bach's views, though the stages of its hypothetical construction are not the same. We have therefore to ask whether formaldehyde can be detected in plants, and if so whether the conditions under which it may exist admit of its being considered an up-grade product in photosynthesis. Objections to the theory of its formation may be advanced based upon its undoubtedly poisonous nature. Of all the antiseptics now available to the bacteriologists it is perhaps the most potent, even traces being fatal to the form of vegetable protoplasm which is found in bacteria. We may argue that it must be equally deleterious in the cell containing chlorophyl and to the chloroplast itself, as we have no reason to suppose that any difference in vitality exists between the protoplasm of different plants. At first sight this appears an almost insuperable difficulty in the way of the theory. Formaldehyde has, however, the properties of aldehydes in general, one of which is the power of condensation or polymerization. It passes with extreme readiness into much more inert form, para-formaldehyde, a body in which three molecules of the formaldehyde are grouped together. It is therefore possible that it may be prevented from exercising its deleterious properties by a transformation at once into this comparatively harmless modification. This will slowly decompose under proper conditions, giving off the free aldehyde.

Pollacci has stated that it is possible to extract formaldehyde from leaves. In his experiments he took such as had been exposed to light for a very considerable period and then macerated them in water. After a sufficient extraction he distilled the leaves, together with the water in which they had been steeped. The first portions of the distillate yielded reactions indicative of the presence of formaldehyde. His experiments do not enable us to say that free formaldehyde was there, for the more stable *para*-form would be likely to decompose during the distillation, so that the reactions would be explained without demanding the presence of the free aldehyde in the leaves.

But little success has attended hitherto the attempt to show that formaldehyde, in the presence of chlorophyl, or preferably, we may say, of chloroplast, can give rise to carbohydrates. We have nothing more satisfactory than Bokorny's experiments, in which, after failing to set up photosynthesis in a filament of Spirogyra fed with formaldehyde, he succeeded when he supplied the alga with its compound with sodium-hydrogen-sulphite. Experiments on a more comprehensive scale, conducted on a variety of plants of different habits, are needed before we can regard the process as satisfactorily established.

We have further to pursue the problem by an inquiry as to the nature of the sugar first formed. Certain considerations lead to the view that it is probable that a sugar of the aldose type must be accompanied in the plant by a ketose. The hypothesis as stated by Baeyer, and so far accepted until quite recently, took no account of the latter. The aldose *grape sugar* was the one always suggested, and from this all others met with have been held to be constructed. The first appearance of a ketose, *levulose*, or *fruit sugar*, has been associated with the hydrolytic decomposition of *cane sugar*, itself constructed presumably from the grape sugar. I fear sufficient attention has not been paid to probability or to the normal course of chemical action in framing our hypotheses, for it is rather difficult to see how some of the transformations somewhat dogmatically affirmed can possibly take place. I may refer in passing to the statement that in the digestion of fat or oil during germination part of it is converted into starch or sugar.

But to return to the construction of sugar. The condensation of formaldehyde, which can be brought about by the action of basic lead carbonate, leads to the formation of several sugars, each yielding its characteristic osazone. How far the condensation in the plant follows this is still uncertain. It is quite possible that stages intervene between formaldehyde and sugar of any kind. It has been suggested that formaldehyde in the presence of water may under the conditions obtaining in the leaf give rise to glycolaldehyde, a body which forms sugar very readily indeed. The formation of sugar directly from formaldehyde is a much longer process and is attended with greater difficulty.

I may call your attention here to the views of Brown and Morris traversing the theory of the primary carbohydrate being grape sugar. In their classical paper on the chemistry and physiology of foliage leaves, they have adduced strong evidence, based upon analyses of the sugar-content of leaves of *Tropæolum majus*, that in this plant at any rate the first sugar to be formed is cane sugar. Whether or no this is the case in plants generally cannot at present be said, though it appears from many considerations probable.

The part played by chlorophyl in photosynthesis has already been touched upon. Remarkably little is known about chlorophyl itself. It has so far been found impossible to extract it from the chloroplast without causing its decomposition, and hence our ideas of its constitution, such as they are, are based upon the examination of something differing in some not well-ascertained particulars from the pigment itself. A remarkable relationship is known to exist between the latter and iron, for unless this metal is supplied to a plant its chloroplasts do not become green. But the condition of the iron in the plant is uncertain; it seems probable that it does not enter into the molecule of the pigment at all. A remarkable series of resemblances between derivatives of chlorophyl and derivatives of hæmatin, the coloring matter of hæmoglobin, has been brought to light by the researches of Schunck and Marchlewski, which is very suggestive. The same leaning toward iron is found in the two pigments, but in the case of hæmatin our knowledge is further advanced than in that of chlorophyl. The iron is known to be part of its molecule. It can by appropriate treatment be removed, and a body known as *hæmatoporphyrin* is then formed, which presents a most striking similarity to a derivative of chlorophyl which has been named *phylloporphyrin*. The two pigments are almost identical in their percentage composition, the hæmatoporphyrin containing a little more oxygen than the other. Both seem to be derivatives of pyrrol. The most striking similarity between them is their absorption spectra, their ethereal solutions both showing nine bands of identical width and depth, those of hæmatoporphyrin being a little more toward the red end of the spectrum. Their solutions in alcohol and ether show the same color and the same fluorescence. Though they differ in certain other respects, notably the facility with which they form crystals, it is impossible to deny that a close relationship seems probable. If this is established, we may by analogy perhaps learn something about the part played by iron in the action of the chloroplast, which so far has proved as obscure as the relation of the metal to the pigment. It is very suggestive to recall the resemblances between the two pigments, the one playing so prominent a part in animal, the other in vegetable life. Both are associated with a stroma of proteid, or possibly protoplasmic, nature, in which a solution of the pigment is retained, apparently after the fashion of a sponge. Both are concerned in metabolic processes in which gaseous interchanges play a prominent part. Both are in some way dependent on the presence of iron for their individuality, even if iron is not actually present in the molecule of both. The iron being removed, the derivatives which are found are almost identical. Further researches may throw a light on this curious relationship, perhaps showing that chlorophyl may enter into a combination with carbon dioxide as hæmatin does with oxygen. Such a combination might well be the precursor of the decomposition of the carbon dioxide which has been already spoken of.

We meet with another pigment in many plants the physiological significance of which has in recent years begun to attract some attention. This is the red coloring matter, *anthocyan*, apparently related to the tannins, which is developed especially in the young leaves of shade-loving plants when they become exposed to illumination exceeding the intensity which they normally encounter. The formation of this pigment is greatest in tropical plants, where it is found usually in the epidermis of the young leaves, though in some cases it extends to the mesophyl as well. The pigment seems in some way to be supplementary to chlorophyl, for its absorption spectrum shows that it allows all the rays useful in photosynthesis to pass through it. It is unlikely that it takes any share in photosynthesis. Several theories have been advanced to explain its presence; it may be simply to protect the delicate cells from the destructive action of too intense light, or to avert the evil of overheating from the solar rays. It has been suggested that certain rays hinder the translocation of starch, and that the pigment shields the cells from the incidence of such rays. Again, the view has been advanced that the red color is important in accelerating the development of diastase from its antecedent zymogen, which has been found to take place under the influence of the rays of a certain region of the spectrum. While all these views have been advanced, however, there is little positive information bearing upon either the formation or the function of the pigment.

Very little progress has been made with the problem of the construction of proteid matter in the plant, which still confronts us. The question of its relation to the mechanism of photosynthesis has received some attention without leading to any satisfactory conclusion. Winogradski's success in cultivating the nitrate bacteria upon purely inorganic matter reveals an unexpected constructive power in some forms of vegetable protoplasm. The question of the energy made use of in proteid construction is in an equally unsatisfactory condition. Laurent, Marchal and Carpiaux have stated that the rays of the violet and ultra-violet region of the spectrum are absorbed and devoted principally to the construction of nitrogen compounds from the nitrates, or the compounds of ammonia, which are absorbed by the plant, while the intervention of the chlorophyl apparatus is unnecessary for this purpose. The experiments which they give in considerable detail upon this absorption carry much weight and appear conclusive. Unfortunately, other observers have failed to confirm them, so that at present the matter must be left open.

Among the problems connected with the nutrition of the plant, the part played by alcohol has recently come into prominence. Alcohol was originally associated only with the lower fungi, and especially with the yeast plant. Biological problems of grave importance arose in connection with the Saccharomyces, apart from what seemed at first the larger question, viz., the nature of fermentation. A prolonged study of the latter phenomenon led Pasteur to the view that alcoholic fermentation is only the expression of the partial asphyxiation of the yeast, and its efforts to obtain oxygen by the decomposition of the sugar. It is hardly necessary here to remind you of the controversies that centered about the question of fermentation and the theories held and abandoned as to its cause. The biological phenomena have, however, a claim now upon our attention in the light of some very remarkable researches that are calling for our attention and criticism to-day. Pasteur's explanation of the behavior of the yeast was, as we have seen, such as to connect it with the respiration of the plant. When oxygen was withheld from active yeast, 60 to 80 parts of sugar disappeared for one part of yeast formed. When oxygen was present, not more than ten parts of sugar were decomposed for the same amount of yeast production. Undoubtedly the stimulus of asphyxiation materially stimulated the yeast metabolism.

But certain observations did not agree with Pasteur's explanation. An energetic fermentation takes place in the presence of oxygen, the plant multiplies extremely quickly, and its metabolism appears very active. Schützenberger argued against Pasteur's explanation with some force, emphasizing these points of disagreement between his hypothesis and the facts, and claimed that the matter rather concerned nutrition than respiration. He based his view on experiments carried out to ascertain how respiration was affected under changed conditions.

The results he obtained were briefly the following:

(1) In a watery liquid without sugar, but containing oxygen in solution, the quantity of oxygen absorbed in unit time by a gramme of yeast is constant, whatever proportion of oxygen is present.

(2) In a saccharine liquid containing albuminous matter as well as sugar, and with oxygen in solution, the same result is obtained, except that the quantity absorbed in unit time is greater.

(3) In two digestions carried on side by side for some time, one being supplied continuously with oxygen and the other deprived of it, the former produced most alcohol.

If the decomposition of the sugar had been the result of the respiratory activity of the yeast cells at the expense of the combined oxygen of the sugar, it would seem that fermentation should either not have taken place at all in the presence of free oxygen or that it should have been much less than in the other case, whereas the reverse is what is found. Hence Schützenberger advocated the view that the sugar is alimentary and not respiratory.

Certain facts more recently discovered support strongly the view that the nutrition of the yeast is the chief object of the process normally, though we cannot deny that when partial asphyxiation sets in, fermentation is resorted to by the plant in its difficulty, that it may obtain the energy normally supplied by the respiratory processes. The mode of decomposition of the sugar, however, the formation of alcohol and carbon dioxide, raises a question as to the exact form in which the nutritive material is supplied to the protoplasm.

Of these more recent discoveries, the work of Devaux on the trunks of trees may be mentioned first, as it seems to point to a similar problem to the one connected with yeast. Devaux examined the composition of the air in the interior of woody stems growing under normal conditions, and found that the proportion of oxygen it contains often sinks as low as 10 per cent, while in a few cases, in the most internal part of the tree, he found this gas to be entirely absent. The disappearance of oxygen becomes easier with every increase of temperature. The partial asphyxiation is attended by the formation of alcohol in the struggling tissue, the spirit being detected by cutting up the

branches of the trees and distilling them with a large excess of water. Devaux's experiments were made upon a considerable variety of trees, among which may be noted *Castanea vulgaris, Pyrus domestica, Alnus glutinosa, Ulmus campestris, Sambucus nigra* and *Ficus carica*.

Similar results have been obtained by Mazé in some researches on seeds. When a number of these are submerged in water, micro-organisms being properly guarded against, they do not readily germinate, but their weight nevertheless somewhat rapidly diminishes. In some of Mazé's experiments with peas, he ascertained that this diminution was attended by a considerable formation of alcohol. Three parcels of forty peas were examined, weighing respectively 10, 17 and 27 grammes, and the experiments lasted six, twelve and twenty-seven days. He found the proportion of alcohol to the original weight of the peas was 2.34, 4.63 and 6.56 per cent. As the peas were submerged, and so kept out of contact with air, it seems possible to suppose we have here again an effect of asphyxiation. Other experiments, however, make this view unsatisfactory. He germinated twenty peas at 22 deg. C. for seven days under normal conditions, till their axes were about 1½ inches long. He then covered them with water, in some cases leaving the terminal bud exposed to air. The development of the submerged plants stopped at once, and at the end of five days the liquid contained 130 milligrammes of alcohol. The seedlings whose terminal buds were exposed to the air continued to grow without showing any disturbance. Mazé concludes that the alcohol produced was utilized by them in their growth, and suggests that it is a normal and necessary product of the digestion of carbo-hydrate material in seeds in course of development.

He goes on to show that alcohol can be demonstrated to be present in plantlets that have germinated for forty-eight hours at 23 deg. C. under normal conditions.

(To be continued.)

"LIVING CYCLE WHIRL."

The "Living Cycle Whirl" is the name of the latest sensation of the variety stage, which is at present presented at the Dresden Victoria Salon and is designed to outdo "Looping the Loop," as well as the cyclists in the "Death Ring."

This performance always evokes enormous applause. It is not a haphazard invention, but the result of well-considered, finely worked-out calculations, which occupied the originators for months.

The performers commence their "act" in an apparently harmless fashion by describing the usual loops and circles of the trick rider, although in more or less daring evolutions, which they endeavor to render more attractive by various difficult, but dexterously executed complications. Thus one of the trick riders suddenly falls literally into the wheels of his partner, while the latter is riding at great speed, and lifts him up machine and all, with one arm, letting him pedal on for quite a while up in the air. Another marvelous feat consists in lifting the wheel and rider with the teeth. The ease and security with which the two artists execute this funny trick—the lower man is hung up on a real clothes-rack—are especially worthy of admiration. The crowning feature of their wonderful performance, however, is the production of the living cycle whirl. The Herculean lower man takes on his shoulders a framework of laths measuring but a few yards in diameter, and resting on an iron substructure. His agile partner leaps upon this living race track, and races several times at a furious pace around the narrow curve, taking great care not to lose his balance on this inclined plane until a short "stop" invites the daring cyclist to dismount.

For a faultless execution of this break-neck trick enormous strength is required of the lower man, which must be coupled with an instinctive feeling for the right balance, following, step by step, the frantic pace of the rider, who in turn finds the greatest difficulty in overcoming the slight diameter of the race course. It is obvious that only by long-continued practice could success have been achieved.—Translated from the Illustrirte Zeitung for the Scientific American Supplement.

THE "LIVING CYCLE WHIRL."

IMPURITIES AND PURIFICATION OF ACETYLENE.

In the Jour. f. Gasbeleucht, G. Keppeler gives a *résumé* of the impurities which have been discovered in acetylene, and the methods which have been devised to remove them.

Phosphorus.—Lewes has found that an acetylene containing less than "80 per cent of phosphine," part of the latter undoubtedly existing as P_2H_4, is not liable to spontaneous inflammation, even if the mixture be warmed with hot water. When generated by the "drip" system, however, the gas coming from a carbide containing 1 per cent of calcium phosphide catches fire of itself, whereas if the carbide-to-water method be adopted, 25 per cent of calcium phosphide is needed to produce the same effect. The highest proportion of phosphine ever met with in acetylene evolved from ordinary carbide has been returned at 2.3 per cent (Lewes), and this gas was not spontaneously inflammable. In fact, only one case of spontaneous inflammation has been recorded, and this dated from the earliest years of carbide manufacture; none of the accidents which have happened with acetylene plants have been due to this cause. Caro has shown that crude acetylene may contain organic compounds of phosphorus, especially if a high temperature has been produced in the generator. These compounds are of a basic nature and contain nitrogen; they may be extracted from the gas by washing with petroleum spirit.

Sulphur.—Properly made acetylene seldom contains sulphur as H_2S. When the gas from a hot generator, and the spent liquor in any apparatus, does contain H_2S. this is due to the influence of the high temperature in the first case, and to the presence of aluminium sulphide in the carbide in the second. In the absence of the aluminium sulphide, Wolff has demonstrated the existence of H_2S in the gas; here the calcium sulphide has probably been converted into calcium sulphydrate by the water, sulphureted hydrogen being evolved from it by the action of heat. The sulphur of crude acetylene exists partly as organic compounds, the proportion being higher if the gas comes from a hot generator. Part of these bodies are soluble in ether and petroleum spirit, part insoluble; the soluble portion Caro rightly considers to consist of mustard oils, the insoluble he holds contain mercaptans. The latter are readily extracted from the gas by an acid solution of cuprous chloride, or oxidized by chromic acid; they appear to be not easily acted upon by bleaching powder. The author has examined the precipitate obtained when crude acetylene is led into mercuric chloride solution strongly acidified with hydrochloric acid. Beyond proving that the precipitate is not identical with that given by phosphureted hydrogen, that it contains mercurous chloride, and that it evolves a gas (which is not precipitated by more mercuric chloride, nor absorbed by caustic potash) on treatment with nitric acid, he has not been able to ascertain its exact constitution. By washing crude acetylene with hot aniline, the existence of Caro's oil of mustard has been corroborated. Attempts to study the impurities by examining spent purifying materials have not been successful. All the sulphur compounds, as well as those of phosphorus, tend to give trouble at the burners, since they block up the fine holes; a proper system of purification should therefore remove both sulphur and phosphorus.

Ammonia.—Crude acetylene always contains ammonia. This may arise from aluminium or calcium nitride in the carbide. According to Lewes, the proportion of NH_3 in the gas ranges from 0.16 gramme (carbide-to-water gas) to 0.95 gramme (drip generator gas) per liter; Rossel and Landriset return the variations as between 0.0 and 0.4 gramme per 100 liters. Ammonia is very objectionable in the gas; it corrodes brass pipes, assists the formation of explosive acetylene-copper compounds, and, according to Von Szepczynski, produces pyrrol at the burner orifices, and so stops them up.

Hydrogen Silicide.—Lewes has asserted the presence of this impurity in crude acetylene, returning its maximum proportion as 0.01 per cent. Did it exist in acetylene in appreciable quantity, hydrogen silicide would be harmful, for it is spontaneously inflammable, and it would block the burners by deposition of silica.

Oxygen, nitrogen (or air), hydrogen, carbon monoxide, methane, unsaturated hydrocarbons other than acetylene itself, and saturated hydrocarbons have all been found in crude acetylene in various amounts; but with the exception of minute quantities of nitrogen and carbon monoxide, which occur in crevices of the carbide, and of hydrogen, which may be produced by the decomposition of phosphine, these foreign bodies are formed by the action of high temperatures in the acetylene generator, or are added, as air, to the gas by a badly designed apparatus. They do not, therefore, have to be removed by methods of purification; their formation must be prevented. They are objectionable because, as diluents, they lower the illuminating power of the acetylene, or because they cause stoppages in the pipes. Experiments on the absorption of the true acetylene in crude gas by means of sulphuric acid containing 25 per cent of SO_3 have indicated an average gaseous residue of 2 to 2.5 per cent. Eighty per cent of this is air, with nitrogen in some excess. Methane and hydrogen are absent, but 0.6 or 0.8 per cent of the residue, i. e., 0.015 to 0.02 per cent of the original acetylene) consists of carbon monoxide.

For the purpose of gaging the value of the purifying materials described below, the author employed the analytical process he and Eitner have already recommended (Jour. Soc. Chem. Ind., 1901, 938); while he also used a modification of Fischer's apparatus for estimating sulphur in coal-gas. In the latter case the gas was burnt from an acetylene Bunsen under a trumpet connected with a ten-bulb condenser, the lower bulbs of which were charged with beads made of a specially hard glass capable of resisting the attack of phosphoric acid. The purifying material was placed in a glass vessel so that a space of 500 c.c. was occupied, the quantity of substance required to fill it being 400 grammes of (2), 250 grammes of (3), 230 grammes of (4), and 360 grammes of (5). The gas was led through at a speed of 10 liters per hour, tests being made at intervals for the amount of phosphorus and sulphur escaping.

The substances which have been proposed as chemical purifiers for acetylene are five in number: (1) ordinary ferric hydroxide as used for coal-gas, (2) "Heratol," a solution of chromic acid or sulphuric acid absorbed in kieselguhr, advocated by Ullmann. (3) "Acagine," a mixture of bleaching powder with 15 per cent of lead chromate, as recommended by Wolff (the specimen examined by the author containing 15 per cent of barium sulphate as well, and having 16 per cent of active chlorine); and (4) "puratylene," a mixture of bleaching powder with calcium chloride and calcium hydroxide, prepared by a special process to give it porosity, the author's sample containing 18 or 19 per cent of active chlorine. These act by oxidizing the impurities of the gas and by mechanically retaining the less volatile fluid impurities (tar). The last acts by decomposing the impurities. (5) "Frankoline," a solution of cuprous and ferric chloride in strong hydrochloric acid absorbed in kieselguhr, proposed by Frank. Especially for small plants, ferric oxide is practically useless, a crude acetylene containing 0.61 gramme of phosphorus and 0.27 gramme of sulphur per cubic meter still retaining 0.51 gramme of the former and 0.23 gramme of the latter after passing the purifier. Heratol is the most perfect in its action, no other substance removing the impurities so completely until it is exhausted, and no other being so rapid in its effect. One kilo of heratol purifies 5 cubic meters of ordinary gas, the precise amount of CrO_3 present, within certain limits (110 to 136 grammes per kilo), being unimportant. The substance continues to purify until only some 3.6 or 3.8 per cent of the CrO_3 remains unreduced. It acts, however, upon the acetylene itself, in one experiment 13 per cent of the CrO_3 being consumed in this manner. Heratol changes in color in the purifier, altering from its original yellow to a dirty greenish tint. Acagine purifies about 13 cubic meters per kilo, but before it is exhausted it be-

gins to allow phosphorus and sulphur to pass. In contradiction of what has been asserted, acagine does attack acetylene, the gas issuing from the purifier containing 0.2 to 0.8 gramme of chloride per cubic meter. The amount of acetylene destroyed, however, is insignificant, and the added chlorine hygienically unimportant. The value of the lead chromate, which is employed to retain the chlorine evolved from the bleaching powder, seems problematical, for an extraction of the spent mass with acid shows that the chromic acid of the chromate has not been reduced. 1 kilo of puratylene purifies 10 cubic meters of crude acetylene, its action (particularly as regards phosphorus) being satisfactory. It continues to act until it is practically exhausted, the spent mass only containing 2.8 per cent of active chlorine. Puratylene attacks the acetylene itself somewhat more than acagine, the issuing gas yielding 0.14 gramme of chlorine per cubic meter. It retains ammonia perfectly, owing to the calcium chloride in it. Puratylene also begins to let phosphorus pass before it is wholly spent. All purifying materials containing bleaching powder permit the escape of sulphur compounds, but are more efficacious as regards phosphorus; acagine, however, is but little inferior to heratol in this respect, and the quantities of sulphur so left in the gas may be considered harmless, as experience with coal-gas has shown in the past. One kilo of frankoline removes the phosphorized impurities from 9 cubic meters of gas, but it is the least efficient of all the materials as regards the sulphur, leaving 0.20 gramme or more per cubic meter unextracted from the beginning. Still, this amount of sulphur may be held to be unimportant in practice. On the other hand, frankoline does not attack the acetylene itself, and any vapors of hydrochloric acid issuing from the purifier can be removed by chalk. Originally it was claimed that frankoline might be regenerated by exposure to air, but this process is only available in the case of a liquid, and even there it is not complete. Liquid purifying materials of any kind are not to be recommended, since the gas tends to pass through them in large bubbles; a solid substance also retains heavy liquid impurities. Put comparatively, the efficiency of the four materials per kilo may be said to be as follows: Heratol, 5,000 liters; frankoline, 9,000; puratylene, 10,000; acagine, 13,000 liters. In practice these numbers may be increased 10 and perhaps 20 per cent, but assertions which have been made giving such figures as, for example, 50,000 liters of ordinary crude acetylene, must be regarded as exaggerated.

Annexed is a bibliography of the subject, references being made to the pages of this journal:

Phosphorus: Moissan, 1899, 517; Renauld, *ibid.*; Caro, 1899, 818; Lunge and Cedercreutz, 1897, 1046.

Sulphur: Moissan, 1898, 1030; Caro, *loc. cit.*

Ammonia: Bamberger, 1898, 745.

Carbon Monoxide: Lundstrom, 1899, 476.

Various Impurities: Lewes, 1894, 505; Rossel and Landriset, 1901, 345.

Purification: Ullmann and Goldberg, 1899, 743; Ahrens, 1899, 819 and 903.

Analysis: Rossel and Landriset, 1901, 345; Eitner and Keppeler, 1901, 938—F. H. L.

Prussian Blue in Spent Oxide: Determination of, H. Lübrig.

EXCAVATIONS AT ABYDOS.

THE following letter from Prof. Flinders Petrie to the London Times outlines his recent work at Abydos:

To the Editor of the Times:

Sir: The continuation of the work of the Egypt Exploration Fund at Abydos this year has given a wider view of the early civilization, of which the general lines had been fixed by the previous work on the Royal Tombs and the town. The clearance of the old temple site over several acres has brought to light, in a depth of about 20 feet, no less than ten successive temples ranging in age from about 5000 to 500 B. C. For the first time we can see on one spot the changes from age to age through the whole of Egyptian history. To separate these buildings was an affair of anatomy rather than spade work; the walls of mud brick were so commingled with the soil that incessant section-cutting with a sharp knife was the only way to discriminate the brickwork. Often only a single course of bricks or a thin bed of foundation sand was all that told of the great buildings which had existed here for centuries. Over 5,000 measurements were taken for the plans and levels. The main result as regards the religion is that Osiris was not the original god of Abydos; the jackal god, Upuaut, and then the god of the West, Khentamenti, were honored here down to the XIIth dynasty. The most striking change is seen about the IVth dynasty, when the temple was abolished, and only a great hearth of burnt offering is found, full of votive clay substitutes for sacrifices. This exactly agrees with the account of Herodotus that Cheops had closed the temples and forbidden sacrifices. This materializing of history is made the more real by finding an ivory statuette of Cheops of the finest work, which shows for the first time the face and character of the great builder and organizer who made Egyptian government and civilization what it was for thousands of years after. This carving is now in the Cairo Museum.

The discoveries of the civilization of the Ist dynasty, the beginning of the kingdom, expand what we already had from my work in the Royal Tombs. Of Menes, the founder, we have part of a large globular vase of green glaze with his name inlaid in purple; thus polychrome glazing is taken back thousands of years before it was previously known to exist. The free use of great tiles of glaze for wall coverings shows how usual the art was then. In the highest art of delicate ivory carving there are several pieces of this age; especially the figure of an aged king, for its subtlety and character, stands in the first rank of such work, comparable to the finest carvings of Greece or Italy. We must now reckon the earliest monarchy as the equal of any later age in such technical and fine art.

Pottery of forms and material quite unknown in Egypt also belongs to this remote age; and it proves to be identical with that in Crete of the late neolithic age. This fresh connection illustrates the trade and the chronology of that period. A head of a camel modeled in pottery takes back its relation to Egypt some 4,000 years; hitherto no trace of it had appeared before Greek times. An ivory carving of a bear extends also the fauna of early Egypt.

The great fort long known as the Shunet ez Zebib is now connected with the remains of another fort, which was discovered between that and the Coptic Deir, which is in a third fort. These buildings prove now to have been the fortified residences of the kings of the IId dynasty, whose sealings we have found in the dwelling rooms.

Of a later age may be noted some large decrees of the Vth and VIth dynasties, the oldest example of iron yet known, which is of the VIth dynasty, and in the XVIIIth dynasty a great memorial tablet of the grandmother of that line, and the remains of a cliff temple of the type of Deir el Bahri. These are but the salient points of a winter's work of much historical interest. The collection will be exhibited as usual at University College, Gower Street, from July 1 to 25.

Unhappily, the growing lawlessness of Egypt, which Lord Cromer noticed in each of his recent reports, has affected our work; and "a large number of offenses, not very serious in themselves, but which cumulatively become serious, have been committed, and but too often have been committed with impunity." (Report, 1902, p. 40.) A statue was stolen from my house; and though the footprint of the thief exactly agreed with the very peculiar foot of one of the men who were notoriously accused in the village, and all the links were named by witnesses, yet no conviction could be obtained; £35 are said to have changed hands as bribes over this. Next, my workmen from Quft were subject to a general conspired assault in the market, and each robbed of his money at once. But no redress whatever could be obtained. The police officer added to the injury by taking away one man who had been beaten to see the doctor, who did nothing but detain him till he paid 10s. bribe to be let go. Last year the relations of a man who died of fever were mulcted of £6 by another doctor; and, on my complaining, the official inquiry resulted in giving an account which was absurdly false, to my personal knowledge.

It is impossible that the present machinery can work to elicit the truth. Witnesses are examined by petty officers, who dictate the final statement of evidence at their own will; and the witnesses are summoned through their sheikh, who is the first man to be "squared" by the offenders, and "who, they think, will assuredly, sooner or later, endeavor to wreak his vengeance on them." (Report, p. 36.) Such a system—dating long before the British occupation—is the most perfect for facilitating bribery and the suppression of truth. This is not the place to discuss the remedies. Happily, Lord Cromer considers that "the points which most require attention are the police, the Department of Justice, and sanitation." I do not touch on more personal threats to our party and being fired at, as I only wish here to refer to the failure of justice. But matters have gone so far that we must look for safety to our own resources rather than to the law, which has in each case proved to us useless.

I remain, your obedient servant,

W. M. FLINDERS PETRIE.

University College, June 22.

THE DIPLODOCUS CARNEGGII AS IT WOULD HAVE APPEARED WHEN LIVING IN PREHISTORIC DAYS.

THE DIPLODOCUS CARNEGGII.

A SKELETON of this creature, which is 60 feet long, is to be given by Mr. Carnegie to the Natural History Museum. The *Diplodocus* is very similar to the *Cetiosaurus Leedsi*, the tail and hind-leg bones of which have lately been acquired by the Museum. It was a vegetable feeder and amphibious, and never came entirely out of water on account of its size and weight, which was so enormous that it could not support itself without the help of water. It was discovered by Mr. Hatcher in Wyoming. It is a little difficult for the ordinary person to realize from a skeleton what these uncouth creatures were like. To help the imagination the artist has skillfully clothed this specimen with flesh with the assistance of scientific experts.—The Graphic.

RAILWAY RECEIVERSHIPS.

THE number of railways in the hands of receivers on June 30, 1902, it appears, was 27, showing a net decrease of 18 as compared with the fiscal year 1901. The number of railways placed in the charge of receivers during 1902 was 4, and the number of railways taken from the management of receivers was 22. The roads under receivers operated 1,475.32 miles of line, of which 1,161.66 miles were owned by them. Of the roads managed by receivers, 1 had an operated mileage in excess of 300 miles, 3 between 100 and 300 miles, and 19 less than 100 miles. As nearly as ascertainable the capital stock represented by the railways in the charge of receivers on June 30, 1902, was $18,267,677, funded debt $25,156,977, and current liabilities $4,476,399. These figures show a decrease in capital stock represented, as compared with 1901, of $31,210,580, and in funded debt of $29,591,685.

MILEAGE AND CLASSIFICATION OF RAILWAYS.

On June 30, 1902, the total single-track railway mileage in the United States was 202,471.85 miles, this mileage having increased during the year 5,234.41 miles, this increase being greater than that for any other year since 1890. The 21 States and Territories for which an increase in mileage in excess of 100 miles is shown are as follows: Arkansas, California, Georgia, Idaho, Illinois, Indiana, Iowa, Louisiana, Michigan, Minnesota, Missouri, Montana, North Dakota, Ohio, Texas, Washington, West Virginia, Wisconsin, Indian Territory, New Mexico, and Oklahoma.

The reports made by carriers to the Interstate Commerce Commission cover nearly all the railway mileage in the country other than that of street lines. For the year under review the operated mileage respecting which detailed returns were made was 200,154.56 miles, including 5,387.11 miles of line on which trackage privileges were exercised. Including tracks of all kinds, the aggregate length of railway mileage was 274,195.36 miles, which was classified as follows: Single track, 200,154.56 miles; second track, 13,720.72 miles; third track, 1,204.04 miles; fourth track, 895.11 miles, and yard track and sidings, 58,220.93 miles. From these figures it is noted that there was an increase of 8,843.07 miles in the aggregate length of all tracks, of which 3,306.07 miles, or 37.39 per cent, were due to the increase in yard track and sidings.

The number of the railway corporations included in the report was 2,037. Of this number 1,016 maintained operating accounts, 784 being classed as independent operating roads and 232 as subsidiary roads. Of roads operated under lease or some other form of contract, 321 received a fixed money rental, 165 a contingent money rental, and 257 were operated under some other form of agreement or control. During the year railway companies owning 7,385.99 miles of line were reorganized, merged, consolidated, etc. The corresponding item for 1901 was 8,969.55 miles.

THE SIZE OF ATOMS.

THE theoretical constitution of matter has, it may be said, no interest for engineers, who find quite enough to occupy them in the practical characteristics of the materials of construction. Yet we feel certain that considerable numbers of our readers would repudiate any imputation that their range of thought did not extend to the physical problems with which the scientific world concerns itself. A further reason for writing now about a curious question which has recently been raised, is found in the fact that technical

education by no means shuts out recondite physical problems from the field of instruction; and so long as the student has to learn something about thermodynamics and electricity, it is out of the question to exclude molecular physics from his range of reading. Such facts are our excuse for bringing prominently before our readers certain propositions laid down by Lord Kelvin, which, if we understand him aright, involved a startling change in our concepts of heat, light, magnetism, and electricity.

Mr. H. O. Ridout read before the Physical Society a paper on the size of atoms. We have come to be so imbued with the notion that all matter is made up of little grains that we have some difficulty in forming any other concept of its constitution; and this circumstance augments our incapacity for forming a definite idea of that jelly-like, structureless ether, concerning which Sir Oliver Lodge has written so graphically in past times. If, now, matter is composed of atoms, then these atoms must have some dimensions. They are supposed to be spherical. As far back as 1883 Sir W. Thomson—now Lord Kelvin—had arrived at the conclusion that atoms or molecules, as representing the smallest quantities of matter possessing the attributes of the whole mass, had a diameter which would require from ten to one hundred millions to form a line four-tenths of an inch long. Within comparatively a recent period, however, it has been asserted that each of the atoms is really build up of something much smaller, to which the name of "ions," that is, things which have motion, has been given. It will be understood that on this hypothesis water consists, it is true, of two atoms of hydrogen and one atom of oxygen in each molecule of water; but each atom of oxygen and of hydrogen consists solely of a multiple of ions, or smaller particles. Mr. Ridout has calculated the dimensions of the atoms of a gas. It is quite outside our purpose to do more than denote in general terms the nature of his investigation. Briefly stated, his method consists in finding a pair of spheres which would be charged by the quantity of electricity known to be necessary to electrolyze a given quantity of the body under examination—say water—to the known difference of potential of its ions; and from this quantity the size of the ions, and hence the atoms, is directly arrived at subject to certain conclusions with which we need not concern ourselves further. It may be asked, Whence comes the ion theory, which was not heard of until a very few years ago? The answer is that it has been in a measure forced on the world by the performances of "X" or Röntgen rays, and it is important to remember that these rays—whatever they are—will pass freely through various substances, as, for example, wood, and with the utmost difficulty through metals, such as lead. So far it has been found impossible to make the vibratory theory of light fit in with X-ray phenomena, and something closely approaching a corpuscular theory has been devised to explain them. In other words, ions are supposed to do the work, these ions being charged with electricity, and moving at almost the velocity of light, or, say, 180,000 miles in a second. The theory has much to recommend it, and although not universally accepted, is regarded with considerable favor.

We must now go back, so to speak, to say something concerning the nature of heat, light, electricity, and magnetism. It has long been taught that heat is nothing but a mode of motion; but concerning the precise nature of that motion little or nothing is known. It is supposed that the molecules of a hot boiler plate are in rapid vibration; but the precise nature of the vibration, and how far it is dependent on the action or influence of the all-pervading ether, no one comprehends. It is enough to say here that at one time heat was regarded as a fluid, and known as "caloric." It was not until 1798 that Rumford made his classical experiment with cannon, and wrote: "It appears to me to be extremely difficult, if not quite impossible, to form any distinct idea of anything capable of being excited and communicated in the manner the heat was excited in those experiments except it be motion." More than forty years elapsed before the caloric theory was finally abandoned. To Clerk Maxwell the world is indebted for the splendid magneto theory of light. For years too numerous to count, light, magnetism, electricity, and heat, have all been associated in one family, akin in a multitude of characteristics; only, indeed, separated by individual idiosyncrasies. If, now, under these circumstances, it were proved that any one of the four was not a mode of motion, but a specific substance or special form of matter, then it follows that the whole structure of hypotheses that has been built up and founded on the supposed concatenation of phenomena would fall to the ground. If we keep this proposition in mind, which appears to be incontrovertible, we shall be better able to comprehend the importance of the language which Lord Kelvin is reported to have used in the course of the discussion on Mr. Ridout's paper. He showed that, from mathematical considerations, a single atom of matter charged with a single atom of electricity or electron, would still preserve its symmetry, and he went on to speak of "the atom of electricity" coming out of the atom of matter. He supposes the ultimate atom not to be hard, but plastic, and normally carrying its atom of electricity at its center. Those who desire to go into the electronic theory we may refer to such authorities as Sir Oliver Lodge and Dr. Fleming. We need only confine our attention to the precise statement made by Lord Kelvin. According to all precedent, the word "atom" applies in the language of physical science to matter. An atom is a thing, not a condition, not a mode of motion. Now, either Lord Kelvin spoke of an atom of electricity in this sense, or he did not. If he did, then the analogy or approximate identity of heat, light, electricity, and magnetism must be discarded as an untenable view, and so we get back to the old corpuscular theory of light, and the old caloric theory of heat. If, however, Lord Kelvin did not use the word "atom" in this sense, then he has misused it, and it remains to be seen what meaning he really intended to convey. The interest in such utterances by leading men is not diminished by the circumstance that Prof. Osborne Reynolds—a very eminent authority on physics—in the course of his Rede lecture—a very remarkable production, of which we shall have more to say—not only advances a startling theory of gravity, but told his hearers in all seriousness that he and they were "nothing but ether waves." Matter apart from ether does not exist. It is the ether conditioned by force.—Engineer.

ENGINEERING NOTES.

The total number of sea-going vessels of all nations which entered the port of Hamburg in 1902 was 13,284, and their net registered tonnage 8,689,000 tons, while the total number cleared was 13,283 of together 8,666,000 tons. Of the ships entered last year 9,012 of together 7,855,000 tons were steamers, and 4,272 of together 834,000 tons were sailing vessels; 9,624 ships of together 7,943,000 tons entered this port last year with cargoes, and 3,660 ships of together 746,000 tons entered in ballast.

An estimate of the water power developed in the several countries was given by A. Gradenwitz, in a paper before the Frankfort Congress of German Naturalists and Doctors. His figures are as follows: Germany and Austria, 180,000 horse power; Switzerland, 160,000 horse power; Sweden, 200,000 horse power; the United States, 400,000 horse power. He estimates the total power available in a number of countries to be: Sweden, 2,000,000 horse power; France, 10,000,000 horse power; Germany, Austria, Switzerland, and Italy, together, about 10,000,000 horse power; while in the United States the Niagara Falls alone could furnish 10,000,000 horse power.

A train of Pullman cars recently tumbled down a 35-foot embankment on the Southern Pacific Railway while running at a speed of 35 miles per hour. Four cars jumped the track, but, strange to say, the injuries to them were very slight, and the passengers suffered only from being turned upside down half a dozen times in transit to the bottom. The cars weigh 50 tons each and were rolled over and over like logs, but even the roofs were intact after the accident. The strength of Pullman cars is very clearly shown by their being able to endure such a strain with so little damage to them.

At a recent general meeting of the French Mechanical Construction Company (formerly the Cail Works) the president, Mr. Le Chatelier, made the following statement in reply to questions from stockholders: Recently in tendering for locomotives in Spain we found ourselves in competition with German builders who had lowered their prices to a point apparently below cost, though they were receiving orders from their own government at prices better than we can obtain for similar work in France. This condition of affairs is difficult to meet. Our export business, however, is only a small fraction of our production. The number of locomotives ordered each year by the French railroads varies greatly. In some years orders have been placed amounting to several times the maximum production of the French locomotive works, and locomotives have been ordered abroad; in Austria, in Belgium, and even in America. Orders were placed in America chiefly for the purpose of securing for comparison examples of American construction. These locomotives have certain good points of design, but they show a carelessness in construction to which we are not accustomed. At the present time our works at Denain are not only among the best equipped in France, but are equal to the best in Europe. The cost of production has been reduced more than I dared to hope. During the past 15 months very few locomotive orders have been placed. The question has arisen as to whether it is not better to take orders for locomotives at a very low figure rather than not to take any at all. We decided in the affirmative and have lowered our prices sufficiently to secure orders. We have secured nearly all the orders given out during the past 15 months and have brought our prices to a point which a year ago was entirely unforeseen. This decrease in prices has surprised everyone, and while securing us the most flattering comments has given a satisfactory margin of profit.

On April 20 the King of England laid the foundation stone of the new breakwater at Malta. Malta has two harbors—Quarantine Harbor and Grand Harbor—but the improvement will be confined to the projection of the latter, in which nearly all of the commerce of the islands is carried on. It is also the headquarters of the large British Mediterranean fleet and the location of the Admiralty dockyards. In a northwest gale, Grand Harbor has been a dangerous place to enter. When the breakwater is completed, not only will the bay be a safe and available place of anchorage at all times of the year, but extra space will be made by dredging, and additional moorings will be provided to meet the urgent need of berthing accommodations which have been required of late years. The contract was let to Messrs. Pearson & Son, Limited, and the amount to be paid for the work is, approximately, $5,000,000. It is expected that three years will be consumed in completion. The foundations of the breakwater will be cut into the solid rock in a depth of water varying from 25 to 70 feet, and will consist of concrete mass work carefully leveled to receive the blocks of concrete weighing 40 tons each, of which the superstructure will be built. These blocks of concrete will be made at St. Paul's Bay—12 miles from the works—and brought down in lighters to the site. The breakwater itself will be constructed with two arms. The inner one will extend from Fort Ricasoli 400 feet northwest, with a thickness varying from 38 to 40 feet, and will terminate in a circular end, on which a light-house will be erected about 40 feet above the level of the sea. Seaward of this arm will be a wave breaker, consisting of 40-ton blocks of concrete thrown pell-mell into the sea. The outer arm will start about 224 feet from St. Elmo Point and run 1,240 feet northeast, with a thickness of from 48 to 52 feet, and terminate in a light-house similar to that at Ricasoli. In order to allow passage for boats, and to prevent stagnation of the water in the harbor, the long arm will not be built right up to St. Elmo Point, but will be connected to it by a steel viaduct 224 feet long. American concerns dealing in supplies likely to be needed in the work should confer with the head office of the company in London.

ELECTRICAL NOTES.

A recent issue of L'Electricien contains an interesting discussion of those properties of gutta percha which make it valuable in electrical applications. At ordinary temperatures, gutta percha is as durable as wood. It is flexible and as tenacious as leather; at temperatures from 100 to 500 it becomes plastic and capable of being molded, and upon being cooled it returns to its original condition. The temperature at which it may be worked depends upon the purity of the material. Good gutta percha should not become plastic until it has reached 70 to 75 deg., while the presence of certain adulterants causes it to become soft at 35 deg. The purer the material, the more quickly does it regain its original position. Low temperatures do not affect it. Density of the material varies with its purity, pure gum having a density approximately equal to that of water. Its electrical properties vary with its purity. A thickness of one millimeter of good material can stand 16,000 volts. It is not soluble in water or alcohol, although the resines used in adulterating it are. This suggests a method of purification. It is, however, soluble in carbon bisulphide, chloroform, and toluene. With heat, it may be dissolved by turpentine, certain oils, and benzine. It resists the action of all acids except concentrated sulphuric and nitric. When exposed to the air, it deteriorates slowly, but lasts indefinitely under water. Methods are given for analyzing the material and for determining the purity. The pure gum consists of three chemicals; one a hydrocarbon and the other two oxides of this hydrocarbon. It is suggested that the original gum consists of the hydrocarbon alone. A good quality of gutta percha contains 65 per cent of the pure article.

Zeitschrift fur Elektrochemie contains details of experiments carried out by Foerster and Denso with graphite and platinum anodes in various electrolytes. The graphite anodes were supplied by the Acheson Graphite Company, of Niagara Falls. The tests made with this material were on the same lines as those made by Sproesser, referred to in these columns on January 31, 1902. The specific gravity of the Acheson graphite was 2.14, and the ash contents only 0.83 per cent. Tested in an 8 per cent sodium hydrate solution at 20 deg. C., the oxidation at the anode amounted to only 2 per cent, as compared with 50 to 78 per cent when ordinary carbon was employed in such a solution. With an electrolyte of sodium chloride, containing some chromate, at 60 deg. C., the figures were 7.4 and 12.41 per cent respectively. With a 20 per cent solution of sulphuric acid at 18 deg. C., the Acheson graphite was, however, no more resistant than ordinary carbon. Upon these results the author bases the statement, that the higher the hydroxyl concentration of the electrolyte, and the lower the potential at which the oxygen ions are discharged at the surface of the anode, the greater is the superiority of the artificial graphite over the ordinary varieties of carbon. The experiments with platinum anodes were made with alloys of platinum and iridium (7.6 to 15 per cent of Ir) supplied by Heraeus, of Hanau, in thin foil of only 0.007 mm. thickness. Potassium chloride, sodium chloride, and hydrochloric acid solutions were used as electrolytes in these experiments, with temperatures varying from 20 deg. C. to 80 deg. C. The experiments showed that a slight loss in weight which occurred in some cases quickly fell to nil on continued electrolysis, and was, therefore, to be ascribed to surface inequalities or impurities of the foil, probably introduced by the rolling operation. The fact that this loss is not a continuous one, coupled with the fact that the Hanau firm can now supply platinum electrodes with a superficial area of 2 square meters, weighing only 2 grammes as regards the platinum, is held by the authors to prove that platinum is likely to compete in the future with carbon and graphite as anode material for alkali cells.

It appears to be difficult to determine whether it is more economical, even in large cities, to operate an isolated plant for electric light and power, or to use a central station supply, so conflicting are the views held upon the subject and so admittedly indefinite is the information obtainable from those most capable of imparting that information. There is no doubt that the central station can develop electrical energy at a much lower figure than even a fair-sized isolated plant, perhaps at one-third less for coal alone, besides which the central station, as a rule, has a high load factor and improved facilities for economically handling coal and ashes, and thus has lower labor charges per kilowatt-hour than the isolated plant. There are, however, against these advantages the heavy losses in distribution between the switchboard at the central station and the consumer, which may be as high as 50 per cent, and rarely less than 20 per cent. It would at first seem that there should not be much doubt that the central station source of supply is cheaper than the isolated plant for small users of electrical energy, although even in this case the fact that the central station rate per kilowatt-hour is greater to the small user than to the large user is in favor of an isolated plant for the small user. Such statistics as are available show that savings have frequently followed the installation of comparatively small isolated plants. One thing that conduces largely to this result is that steam is necessary in a building for heating purposes, and thus, so far as the electric plant is concerned, labor charges are almost eliminated. The cost to the consumer of electrical energy from the central station supply, in American plants, ranges from four to fifteen cents per kilowatt hour and that of the isolated plant from two to twelve cents per kilowatt-hour, with an average in the latter case of less than six cents per kilowatt-hour, depending on the conditions prevailing in each building. Where gas engines are employed to operate the dynamo the average cost per kilowatt-hour is somewhat higher. Notwithstanding these figures, however, the central station inspectors appear able to give convincing reasons why it is advisable to use their supply, as proved by the large number of isolated plants in some of the large American cities that have been shut down, their places now being taken by the central station supply.—Cassier's Magazine.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

The Osaka Exhibition.—I inclose herewith a list* of the exhibits at the Osaka Exhibition made by the State of Oregon and call attention to the fact that Oregon is the only American State which has gone to any expense in order to make an exhibit at this fair.

Colonel Dosch, the very active and efficient commissioner in charge of the Oregon exhibits, is making the most of the very small appropriation of $4,000 set aside by that State to help show up its products.

The Oregon exhibits have no State building, but are housed in the Foreign Samples Building, alongside the Canada Building, which, with its contents, is reflecting no small degree of credit upon Canada. It is said that the Dominion has expended the sum of $70,000 upon this enterprise, and its efforts to make a good show stand in marked contrast with the inactivity shown by the United States.

The Canadian commissioners are distributing a great number of pamphlets in the Japanese language, descriptive of their products, copies of which, in English, I am forwarding the Department.

One of the principal features inside the Canadian Exhibition Building is the great rush by the Japanese each day at 4 P. M. to purchase biscuits and loaves of bread baked in full view inside the building. Hundreds of these people then stand with their arms over the railing and money in their hands, ready to purchase, all clamoring loudly to be waited upon. The bread is made of hop yeast and is in much greater demand than the supply. It is expected that in future Canadian flour will be in great demand, as the bread made from it is of most excellent quality. Had some of our Northwestern States been in evidence at the Osaka Exhibition with their hard-wheat flours, the fact could have been demonstrated that our flours are just as good and can make as much bread as the Canadian flour on exhibition.

Among the smaller countries exhibiting may be mentioned Dutch East India, the commissioners for which have issued a large pamphlet describing their exhibits and the resources of their country.

Other American exhibits than those from Oregon are found scattered promiscuously throughout the Foreign Samples Building and some are included in displays made by foreign firms in Japan; but considering the extent of our country and its immense resources, it is plainly evident that there has been a considerable lack of interest at this exhibition upon the part of American exporters.

Germany has taken much interest and some small states have made very considerable exhibits.

The largest foreign exhibit is from Austria, to defray the expense of which the government has appropriated 100,000 guilders ($40,600). The principal exhibits of this country (Austria) are machinery, printing presses, planing mills, spinning machinery, and fire engines. Altogether, it is a splendid exhibit.

England is poorly represented, but not so poorly as is the United States.

Colonel Dosch, the Oregon commissioner to the Osaka Exhibition, has organized a Japanese syndicate to take over his exhibits at the close of the exhibition, thus giving practical effect to the efforts of his State.

This syndicate is organized and incorporated with a cash capital of 300,000 yen ($150,000) to handle Oregon products and manufactures. A representative of the syndicate will join Colonel Dosch and remain with him until the close of the exhibition in order to become familiar with the merchandise to be handled in future.—Samuel S. Lyon, Consul at Kobé.

Consul Lyon also transmits clippings from newspapers regarding the Osaka Exhibition, from which the following information has been taken:

At the great exhibition opened in Osaka the Germans, as usual on such occasions, are very much in evidence. All kinds of German goods, from pins and needles up to locomotives, agricultural machines, etc., are to be seen. The persistency with which the Germans, merchants and manufacturers, exhibit their wares is the very best evidence in their favor. As at Chicago in 1893 and in Paris in 1900, so now at Osaka Germany among foreign states is making a good showing.

German Coal in France.—Something akin to consternation has been caused in coal circles in this part of France by the bold and determined efforts of the Germans to capture the market for steam and forge coal. Some six or eight months ago the English and French concerns which have heretofore almost exclusively controlled the fine market of Nantes and the entire region of the Lower Loire entered into some sort of an agreement or trust by which they sought to put up prices and at the same time to continue their hold upon the business. The price of fuel coal at Nantes, in pursuance of this agreement, was at once advanced some 14 francs ($2.70) a ton, and the combine was about to put up the price of steam coal when the Germans appeared upon the scene and began to bid actively for the business at much lower prices than the French and English dealers had dreamed of. The result was that they began to get the business then, and are still getting it, much to the consternation of their French and English competitors. The greatest gain the Germans have yet scored was reached last week when they secured from the state railroad a contract for 8,000 tons of steam coal at 23 francs ($4.44) per ton delivered on board the cars at the seaport of La Pallice, near La Rochelle. The next lowest bidder was the Compagnie Charbonniere de l'Ouest, of Nantes and Paris, which handles in France the products of certain large Welsh mines. This company is reported to have bid 23.75 francs ($4.59), this being 75 centimes (14¾ cents) per ton above the German price.

As above stated, this German invasion has caused something very close to a panic in French and English coal circles, and the situation is made more serious by the fact that the German coal, which comes from the Ruhr country, has given excellent results at several large factories in Nantes and is preferred by those who have examined and used it to either the French or English coal.

It is stated that at a trial made at the manufactory of the Pilon Brothers some weeks ago 4,500 kilogrammes (9,900 pounds) of German steam coal gave the same results as 5,760 kilogrammes (12,672 pounds) of Swansea coal. It is rather the question of price than quality that is hurting the English and French dealers, and they admit that they cannot, without loss, undersell the Germans at the prices now quoted by the latter. In explanation of the successful German invasion, it is freely declared at Nantes that the German coal importers are now accorded an export bounty by the German government on coal exported to France, but as far as I can learn here there is no positive authority for this statement. It is also stated here that the purpose of the Germans is to compel the French and English, who have heretofore controlled this market, to take them into their combine and share the business at equal prices.

It was believed two years ago, when American coal began to arrive here, that a big market for that product would be created throughout this great industrial region, but after sending about 15,000 tons in 1901 and some 5,000 tons in 1902 the American exporters disappeared entirely from the market, and during the present year not a single ton of our coal has arrived at Nantes—a fact, of course, which is easily explained by the great strike in the United States.

The following table shows the imports of coal at Nantes and St. Nazaire during the years 1900-1902:

Coal.	1900. Tons.	1901. Tons.	1902. Tons.
Welsh and English	1,528,013	1,476,728	1,376,317
American	....	15,000	5,000
German	....	1,905	22,452
Belgian	1,365	300	725

—Benjamin H. Ridgely, Consul at Nantes.

Manufacture of Musical Instruments in Germany.—The manufacture of pianos in Germany has reached a state of perfection attained by no other nation. Admitting that in other countries particular firms produce instruments which in every respect are equal to the best German make, it is claimed that as an industry, considering the number of factories and the high exports to nearly every country in the world, the manufacturers of this empire are a long distance in advance of all their rivals. In spite of the enormous sale of pianos every year within the limits of the empire, the manufacturers are dependent upon the markets of foreign countries for the sale of fully one-half of the number produced.

The success of the German pianos is due to the fact that they are cheap, comparatively speaking. Two hundred and fifty dollars will buy a very fine upright piano in this country. The construction is always apace with the latest art designs, special attention being paid to the woodwork; they not only present an elegant appearance, but are solid and durable.

There are 435 piano factories in Germany, which manufacture 80,000 instruments annually. One hundred and forty factories are located in Berlin, 27 in Stuttgart, 21 in Dresden, 16 in Leipzig, 15 in Hamburg, 10 in Leignitz, 9 in Zeitz, while the rest are located in Dresden, Munich, Halle, and Brunswick. During the past twenty years the export of ready-made pianos and parts has increased from $1,900,000 to $6,110,000. Great Britain is at present Germany's best customer, buying over 40 per cent of the total exports. Prior to 1890 Argentina was the best market for German pianos, especially for those made in Halle. Australia is also a chief market, buying nearly $1,000,000 worth of pianos every year. In ten years Belgium has increased her import of German pianos by 100 per cent, while Russia and Holland purchase about $1,000,000 worth a year. In addition to these countries, large quantities are sold to almost every country in South America and to Norway, Sweden, and South Africa.

There are some 265 factories for the manufacture of church organs in Germany. The greater number are small establishments, which produce only for home use. There are a few factories, however, which export to Russia, Great Britain, and Austria-Hungary.

The chief centers for the wholesale manufacture and export of stringed instruments are Markneukirchen and Klingenthal, here in the Saxon Erzgebirge, and Mittenwald, in Upper Bavaria. In Markneukirchen the industry is greatly assisted by the patronage of the state, and an industrial school has been established which is under the supervision of the Saxon government. The export of musical instruments from the Markneukirchen consular district to the United States for the fiscal year ended June 30, 1902, amounted in round numbers to $684,000. The manufacture of the different parts of stringed instruments is carried on chiefly in the worker's own home. The so-called "Hausindustrie" is highly developed, not only in the musical-instrument centers, but in the dress-trimming and kid-glove towns of the Erzgebirge as well. In the manufacture of guitars, zithers, banjos, etc., Markneukirchen is very successful, although the neighboring town of Klingenthal is a close rival. A few years ago two or three firms at Johanngeorgenstadt, in this consular district, started the manufacture of accordions and zithers, which has been attended with considerable success.

In addition to the above named musical instruments, Germany manufactures large quantities of violins, brass instruments, mouth harmonicas, drums, etc. If we take into consideration all the people employed in the musical-instrument factories and the side lines which are akin to this industry, the number will easily reach 30,000.—Ernest L. Harris, Commercial Agent at Eibenstock.

Commercial Travelers in Roumania.—In his recent report on the trade of Roumania for the year 1902, which appeared in the British Board of Trade Journal, the British vice-consul at Galatz writes to his government:

It is very necessary that a commercial traveler in Roumania should be well acquainted with French and German. In order to obtain this result, the firm invokes the aid of a German, who serves his British master for a time and learns where our strength and weakness lie. In the meantime, the commercial traveler does not forget his own interests, and before long he is in the employ of a German firm, who profit greatly by his experience of British and German trade methods. I do not, of course, mean to imply that the same person, when in the employ of a British firm, failed to serve his master with diligence and fidelity.

In the case of the commercial traveler being an Englishman, he will often be found to be deficient in knowledge of the language of the country. Unlike the German, he does not think of calling on the consul, invoking his knowledge of the place. He forgets, too, that a firm considered safe a year ago may not be so at the time of his visit. No German or Austrian, traveling for a German or Austro-Hungarian firm, would dream of going to various shops, etc., for orders without first paying his consul a visit and making thorough inquiries regarding firms, new and old, and fresh markets.

It is a serious want of consideration on the part of British traders to place their agencies in the hands of persons dealing in, or representing the makers of, similar goods in Austria-Hungary, Germany, etc. On the basis that "no man can serve two masters," it would be prudent to refuse to give the "sole sale" of any particular line of British-made goods to an agent or commission house selling continental makes at the same time. When a sole agency is insisted upon, the conditions should be binding on both parties.

International Exposition at Milan in 1905.—Nachrichten für Handel und Industrie says that the completion of the world's longest tunnel—Simplon—is to be celebrated at Milan, the nearest important Italian city, by an international exposition, for which preparations have been made. It is to take place upon the opening of the tunnel to traffic in 1905. A fund of $600,000 has been raised, of which fully half has been contributed unconditionally. This gives the enterprise a good guaranty to begin with; it makes it sure of an opening. Success will have to depend upon the people exhibiting. The King of Italy has accepted the position of protector. The committee having the matter in charge has established certain fixed rules, with a view to confining the exhibits within certain lines. The departments of transportation by land and water, navigation of the air, and the division dealing with the question of protection from accident in the transportation world, as well as the so-called decorative arts exhibits, may be international in character. The high-art exhibits shall be exclusively national—i. e., Italian. Just why this ruling has been made does not appear. It is provided also that only such products will be admitted for exhibition as have an actual technical or artistic value, or which are characteristic novelties. The purpose of this rule is to prevent the exhibition of cheap bazaar articles.

Industrial Notes from Greece.—The Greek press announces that by the terms of a contract recently closed by the Greek consul at Naples with Italian coral fishers the latter are to come to Greece and search Grecian waters for coral. The Greek ministry has appropriated money for the purpose and has directed the consul at Naples to pay the Italian fishermen an advance installment and send them to Greece at once.

Through the Greek press I learn that Mr. D. Kyriakos, manager of the Hellenic Steamship Company, has submitted to the Greek Minister of the Interior a plan to inaugurate a direct line of steamships between Piræus and the island of Cyprus, touching *en route* at Syra and the island of Rhodes; that the company foresees that the line will not, in the beginning at least, pay expenses and asks assistance from the government; and that the Minister of the Interior is in favor of granting the aid asked.

The firm of Hadzikyriakou, Zachariou & Co. announces that it has opened a cement factory at Eleusis, Greece (on the Bay of Salamis and about 15 miles from Athens), in which it is manufacturing "artificial Portland cement" equal in quality to the best made in Europe, which it offers for sale in Athens and Piræus at the following prices: In barrels, 150 drachmas paper ($12.15) per ton; by the oke, 19 leptas (1.54 cents per 2.8518 pounds); in bags, 140 drachmas ($11.34) per ton; by the oke, 18 leptas (1.46 cents).—Daniel E. McGinley, Consul at Athens.

Shipments of Rubber from Para.—Under date of June 6, 1903, Consul K. K. Kenneday says:

The shipments of rubber from the Amazon Valley during the month of May just passed amounted to 2,070 tons, as against 2,083 tons for the same month in 1902. The total export of rubber for this season—July 1, 1902, to May 31, 1903—is 28,110 tons, as against 28,738 tons for the corresponding period of the previous season. It does not appear likely that the business of this closing month of the season will materially change the relative bearing of these figures. The crop shortage this year, as compared with the year of 1901-2, will therefore be only about 2 per cent, instead of 5 per cent as estimated January 1.

Catalogues of Coffee and Lime Machines for Johannesburg.—Consular Agent W. D. Gordon writes from Johannesburg, June 1, 1903, that if manufacturers will send him catalogues, etc., of machinery for the preparation of coffee and lime for the market he will place them in the hands of interested parties.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. The other Reports can be obtained by applying to the Bureau of Trade Relations, Department of Commerce and Labor, Washington, D. C. Since the number of Reports is limited, application for those which are desired should be made immediately.

* List is on file in the Bureau of Statistics, where it may be seen by parties interested.

SELECTED FORMULÆ.

To Loosen a Glass Stopper.—Run a little glycerin in the neck of the bottle and allow it to stand in a warm place for some time.

Lotion for Mosquito Bites.—

Naphthalin	1 drachm
Oil of lavender	2 drachms
Alcohol	2 ounces

—Drug. Circ. and Chem. Gaz.

Razor Paste.—

Flour of emery	1 ounce
Spermaceti ointment	1½ ounces
Olive oil	¼ ounce

—Drug. Circ. and Chem. Gaz.

Metal Polishing Paste.—

Dried sodium carbonate	1 part
Soap	4 parts
Flour of emery	25 parts
Water, enough to make a paste.	

—Drug. Circ. and Chem. Gaz.

Violet Toilet Powder.—

Starch	5,000 parts
Orris root	1,000 parts
Oil of lemon	14 parts
Oil of bergamot	14 parts
Oil of clove	4 parts

—Drug. Circ. and Chem. Gaz.

May Flowers.—

Essence of rose	10 ounces
Essence of jasmine	10 ounces
Essence of orange flowers	10 ounces
Essence of cassie	10 ounces
Tincture of vanilla	20 ounces
Oil of bitter almond	½ drachm

—Drug. Circ.

Polish for the Finger Nails.—

Eosin	10 grains
White wax	½ drachm
Spermaceti	½ drachm
Soft paraffin	1 ounce
Alcohol a sufficient quantity.	

Dissolve the eosin in as little alcohol as will suffice, melt the other ingredients together, add the solution and stir until cool.—Drug. Circ. and Chem. Gaz.

Nail Cleaning Liquid.—

Tartaric acid	1 drachm
Tincture of myrrh	1 drachm
Cologne water	2 drachms
Water	3 ounces

Dissolve the acid in the water; mix the tincture of myrrh and cologne, and add to the acid solution.

Dip the nails in this solution, wipe, and polish with chamois skin.—Drug. Circ. and Chem. Gaz.

Lily Perfume.—

Essence of jasmine	1 ounce
Essence of orange flowers	1 ounce
Essence of rose	2 ounces
Essence of cassie	2 ounces
Essence of tuberose	8 ounces
Spirit of rose	1 ounce
Tincture of vanilla	1 ounce
Oil of bitter almond	2 minims

—Drug. Circ.

Floor Wax.—

I.

Stearin	10 parts
Yellow wax	3 parts
Soap	1 part

II.

Stearin	4 parts
Yellow wax	1 part

III.

Paraffin	5 parts
Talcum	2 parts

—Drug. Circ.

Grafting Wax.—

I.

Yellow wax	6 parts
Rosin	10 parts
Turpentine	30 parts
Lard oil	1 part

II.

Rosin	125 parts
Pitch	20 parts
Linseed oil	12 parts
Turpentine	5 parts
Yellow wax	13 parts

—Drug. Circ.

Liquid Stove Polish.—The following formula gives a liquid stove blacking:

Graphite in fine powder	1 pound
Lampblack	1 ounce
Rosin	4 ounces
Turpentine	1 gallon

The mixture must be kept well shaken while in use, and must not be applied when there is a fire or light near on account of the inflammability of the vapor.

This form may be esteemed a convenience by some, but the rosin and turpentine will, of course, give rise to some disagreeable odor on first heating the stove, after the liquid is applied.

Graphite is the foundation ingredient in all stove polishes; lampblack which is sometimes added, as in the foregoing formula, deepens the color, but the latter form of carbon is of course much more readily burned off than the former. Graphite may be applied by merely mixing with water, and then no odor follows the heating of the iron. The coating must be well rubbed with a brush to obtain a good luster.

The solid cakes of stove polish found in the market are said to be made by subjecting the powdered graphite, mixed with spirit of turpentine, to great pressure. They have to be reduced to powder and mixed with water before being applied.

Any of them has to be well rubbed with a brush after application to give a handsome finish.—Druggists' Circular.

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